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WATER POLLUTION IN THE CENTRAL MISSOURI RIVER BASIN

Public Health Service
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June 1952

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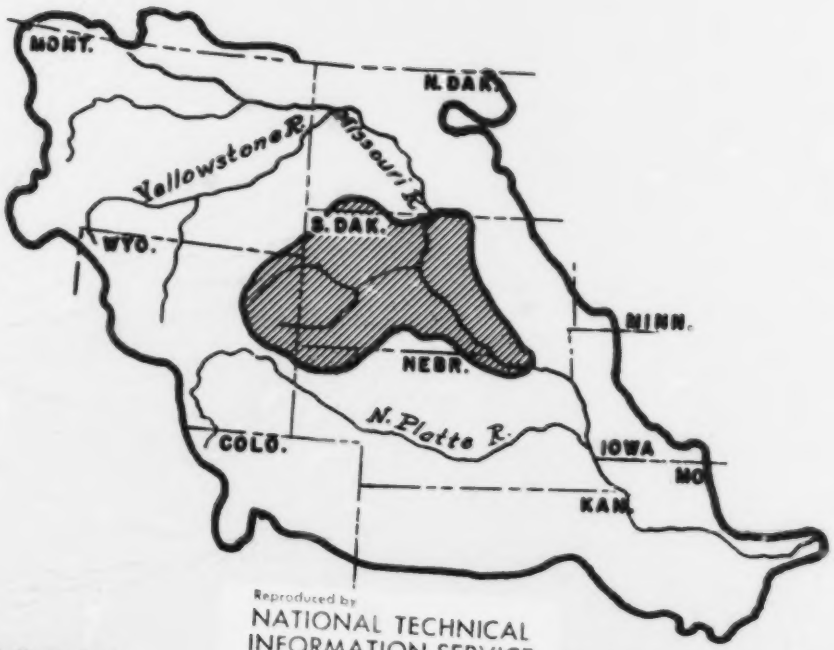
Water Pollution Series No. 24

For Clean Water - "One River, One Plan"

CENTRAL MISSOURI RIVER DRAINAGE BASIN

A COOPERATIVE STATE - FEDERAL REPORT ON WATER POLLUTION

JUNE 1952



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FEDERAL SECURITY AGENCY
Public Health Service

A REPORT OF WATER POLLUTION

IN THE

CENTRAL MISSOURI RIVER BASIN

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Prepared by

NEBRASKA DEPARTMENT OF HEALTH
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Division of Water Pollution Control
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Federal Security Agency
Public Health Service
JUNE 1952

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INTRODUCTION

The Federal Water Pollution Control Act, Public Law 845, passed by the 80th Congress in June 1948, requires the Surgeon General of the Public Health Service to cooperate with other Federal agencies, with State and interstate water pollution control agencies, and with municipalities and industries in the preparation or adoption of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof, and improving the sanitary condition of surface and underground waters. Due regard must also be given to improvements necessary to conserve the waters for public and industrial water supplies, propagation of fish and aquatic life, recreational purposes, agricultural and other legitimate uses.

This report is produced under the cosponsorship of the Nebraska Department of Health, North Dakota State Department of Health, South Dakota State Department of Health, Wyoming Department of Public Health, and the Public Health Service. It is based on data available as of March 1, 1952, on sources of pollution, treatment facilities employed, and stream conditions. The report also presents information concerning use of water resources, pollution entering water resources and resulting damages, benefits which may result from pollution prevention and abatement, pollution prevention measures in effect and those which appear to be needed.

Data and knowledge now available are sufficient to permit the immediate solution of most of the pollution problems within the Central Missouri Basin without awaiting the results of additional surveys and studies.

A sincere effort has been made to present a fair picture of the water pollution problems in the Central Missouri Basin and to present reasonable conclusions and recommendations. It is our hope that this report, as a step in the cooperative development of an ultimate comprehensive water pollution control program, will help in safeguarding the water resources.

ACKNOWLEDGMENTS

The cooperation of the State Water Pollution Control Agency of Nebraska, North Dakota, South Dakota and Wyoming in furnishing data for this report is acknowledged with appreciation.

Acknowledgment is also made to the Corps of Engineers, U. S. Army, Department of Defense; Bureau of Reclamation, Fish and Wildlife Service, and Geological Survey, Department of Interior; the Weather Bureau, and Bureau of Census, Department of Commerce; whose published reports furnished much of the information contained herein on the history, hydrology, stream discharges, population trends, and economic development of the Central Missouri Basin.

Thanks is also tendered to the reviewing agencies, whose comments have materially aided the preparation of the report. These include the

Corps of Engineers, Missouri River Division, Omaha, Nebraska; Bureau of Reclamation, Region 6, Billings, Montana; National Park Service, Omaha, Nebraska; Fish and Wildlife Service, Billings, Montana; Federal Power Commission, Chicago, Illinois; Department of Agriculture, Lincoln, Nebraska; Department of Commerce, Denver, Colorado; the Division of Water Pollution Control, Public Health Service, Washington, D. C.

SUMMARY

The area drained by the central main stem of the Missouri River, from and including Spring Creek to the mouth of the Niobrara River, contains approximately 64,300 square miles. Major tributaries to the Missouri River within this region include the Grand, Moreau, Cheyenne, Bad, and White Rivers. The Niobrara River and Ponca Creek Sub-Basins are considered in a separate report.[1]

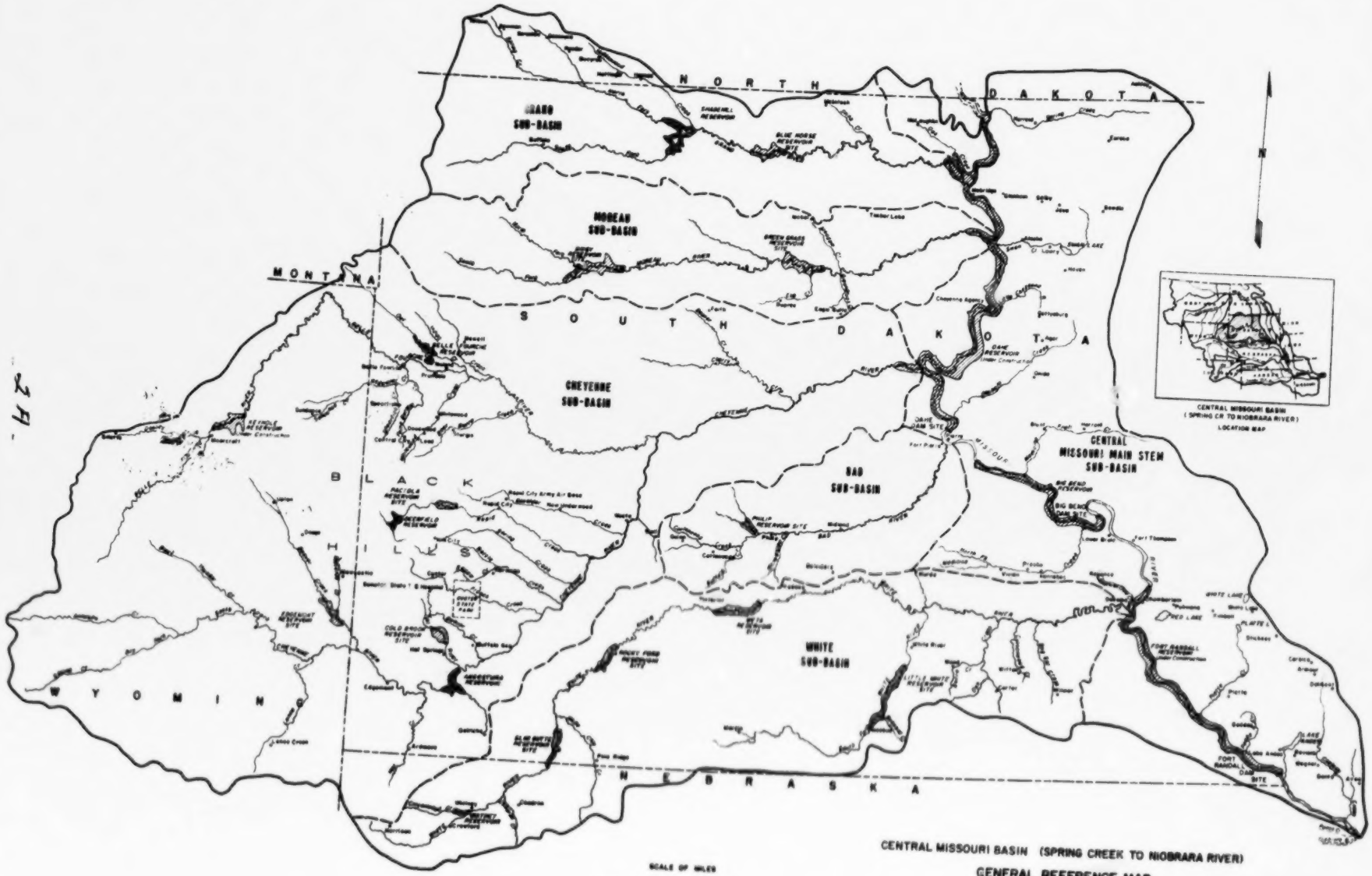
Most of the region is sparsely settled, having an estimated total population of about 170,000 people. Rapid City, South Dakota, is the largest municipality, having a population of 25,177 (1950 census). Other principal cities include Pierre, Mobridge, Belle Fourche and Lead, South Dakota; Gillette and Newcastle, Wyoming; and Chadron, Nebraska.

The economy of the area is based largely upon agriculture and related industries. Other important contributors to the local economy include the mining and processing of gold, the production and refining of oil, and a large tourist trade. The gold mining and tourist industries are centered around the Black Hills. Oil production is focused in the northeastern section of Wyoming. Agricultural pursuits are composed principally of dry-land farming and livestock grazing. The scenic value of the Black Hills, together with recreational attributes furnished by the fish and wildlife resources, are tremendous attractions for tourists from all parts of the nation. Income from the tourist industry has greatly supplemented the local economy.

The completion of the water resource development program of the Missouri River Basin holds promise of considerable improvement and stabilization of incomes for the residents of this semiarid region. The construction of 18 multiple purpose reservoirs will augment existing recreational facilities, will provide water for expanded and new irrigation projects, and will add greatly to the electrical power output for the region's industry. The reservoirs will also provide flood protection to downstream localities. The dams on the main stem will regulate flows in the lower Missouri River for controlling floods and the enhancement of navigation. Three of the proposed reservoirs considered for the Basin have been completed and four more are presently under construction. Two major reservoirs were constructed, prior to authorization of the Missouri River Basin Development Program, to serve irrigation projects near Belle Fourche, South Dakota, and Whitney, Nebraska. The effect of the proposed reservoirs upon a pollution control program has not yet been fully ascertained.

In the Basin 58 municipalities have sewer systems serving an estimated 103,000 people. Twenty-four of the communities have primary

[1]Niobrara River Basin Water Pollution Investigation, January 1951.



CENTRAL MISSOURI BASIN (SPRING CREEK TO NIOBRARA RIVER)

GENERAL REFERENCE MAP

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 1

treatment serving 21,000 people, and 19 have secondary treatment works serving 49,000. Treated and untreated municipal waste discharged to the streams amounts to about 58,000 population equivalents, of which 33,000 are untreated. Eight industrial plants discharge waste to watercourses, the largest of which has a seasonal organic population equivalent of 190,000. The population equivalent of industries connected to municipal sewers has not been fully determined but is much less than that of industries with separate sewers. Inorganic wastes from the mining and petroleum industries have been responsible for some adverse effects on aquatic life of the streams. Municipal wastes have been responsible for localized damages, however the great distances between sources of pollution and the relatively small amounts contributed have enabled the streams to absorb the polluting materials without far-reaching damages to water uses. Although several streams are interstate in character they carry little or no pollution in those reaches and no interstate pollution problems have been reported.

The scarcity of ground water, as well as its objectionable quality, has led to the use of surface water sources for domestic supply at 13 municipalities. The possibilities for increasing the number of surface supplies and the amount of water used from surface sources will be greatly enhanced by the water development program.

In view of the probability of greatly increased water usage within the region, the necessity of protecting such future uses from the effects of pollution becomes more important. Seventeen new treatment plants, enlargements or additions to 11* existing plants, replacement of 6 existing municipal plants, construction of one industrial waste treating plant, enlargements or additions to 4 existing industrial plants, and improved control measures at 2 industrial installations are needed. The estimated cost of providing these facilities, without attending sewer appurtenances and excluding operation and maintenance costs, is $1,600,000.

While considerable progress has been made in pollution control by the Nebraska and North Dakota State water pollution control agencies, their effectiveness would be considerably enhanced if adequate State legislation giving them broader powers were available. Recently enacted amendments to the Wyoming legislation greatly improve that State's water pollution control agency's ability to cope with these problems. Control legislation in South Dakota has proved quite effective.

Table 1 is a list of those municipalities and industries where new or additional pollution control measures are needed, together with the recommended degree of treatment. Map 1 depicts the areas, cities, and rivers.

---

*Rapid City, South Dakota, plant enlargement under construction.

Table 1. Central Missouri Basin - Project list - Municipalities and industries requiring improvements for the abatement of pollution.

Municipality	Population served	Improvements needed	Remarks**
South Dakota			
Avon	500	New plant	Secondary
Belle Fourche	2,500	New plant	Secondary
U & I Sugar Refinery	190,000*	New plant or other pollution control measures	Waste reduction equivalent to secondary treatment
Bowdle	700	Enlargement	Primary
Chamberlain	1,600	New plant	Primary
Cheyenne Agency	-	New plant	-
Deadwood	4,100	New plant	Primary
Edgemont	900	New plant	Secondary
Eureka	1,200	New plant	Secondary
Faith	400	Enlargement	Secondary
Fort Pierre	750	New plant	Primary
Fort Thompson	500	New plant	Primary
Geddes	600	New plant	Secondary
Kadoka	400	Replacement	Secondary
Kimball	800	Replacement	Primary
Lake Andes	800	New plant	Secondary
Lead	7,500	New plant	Primary
Mobridge	3,000	New plant	Primary
Newell	350	Replacement	Primary
Onida	400	Enlargement	Primary
Pierre	4,300	New plant	Primary
Phillip	805	Enlargement	Primary
Presho	400	Replacement	Primary
Spearfish	2,200	Enlargement	Secondary
Rapid City***	25,000	Enlargement	Secondary
Wagner	1,000	Enlargement	Primary
North Dakota			
Bowman	890	Enlargement	Primary
Hettinger	1,600	New plant	Secondary
Nebraska			
Chadron	4,500	New plant	Primary
Crawford	1,700	Enlargement	Secondary

Table 1. Central Missouri Basin - Project list - Municipalities and industries requiring improvements for the abatement of pollution (cont'd.)

Municipality	Population served	Improvements needed	Remarks**
Wyoming			
Gillette	3,200	Replacement	Primary
Moorcroft	300	Enlargement	Primary
Osage			
Maneval & Bradley	-	Better control measures	-
Lance Creek Oil Field	-	Better control measures	-
Newcastle	3,300	New plant	Secondary
Center Oil Refinery	-	Enlargement	Oil separation
Graco Oil Refinery	-	Enlargement	Oil separation
Wyoming Gas & Oil Co. Oil Refinery	-	Enlargement	Oil separation
Sundance			
Crook Company Oil Refinery	-	Enlargement	Oil separation
Upton	600	Enlargement	Primary

*The figure cited is the organic population equivalent (P.E.) of the industrial waste during seasonal plant operations.

**Degree of treatment recommended by the appropriate State water pollution control agency.

***Plant enlargement at Rapid City is under construction.

CONCLUSIONS

1. Sources of pollution are generally separated by great distances from sources of domestic water supplies and little difficulty has been experienced with sewage contamination affecting municipal waters. Most problems arise from local nuisance conditions, destruction of fish life, and from impairment of water quality for recreation, irrigation, and livestock.

2. The State water pollution control agencies, in conjunction with municipalities and industries, are making progress in a program to control the discharges of harmful wastes into streams. The program includes training of sewage and waste treatment plant operators, the publicizing of the adverse effects of pollution, and promotion of new and improved treatment facilities.

3. Legislation giving broader coverage and enforcement powers to a single responsible State water pollution control agency is desirable in Nebraska and in North Dakota.

4. Surface water resources of the area are extremely limited, and water conservation is of uttermost importance to the economy of the region. Control of pollution is a very important aspect of water conservation.

5. The Missouri River Development Program proposes the construction of 18 reservoirs in this Basin, three of which have been completed, four are now under construction, and others are in an advanced stage of planning. All will be multiple-purpose reservoirs in which water will be stored for irrigation, flood control, silt control, fish and wildlife propagation, hydroelectric power, domestic water supply, and pollution control. The large main stem reservoirs will regulate the flow of water in the lower Missouri River for the enhancement of navigation and flood control; for the production of hydroelectric power; and to provide water for municipal, industrial, and sanitation purposes.

6. The need for 17 new sewage treatment plants, enlargements or additions to 11 plants, and replacement of 6 plants, has been determined. No projects are necessary in 25 municipalities.

7. The need for 1 new industrial waste treating plant, enlargement or additions to 4 existing plants, and improved control measures at 2 industrial installations has been established. No project is necessary at 1 industrial plant. The greatest portion of the organic industrial waste is being contributed seasonally by a sugar refinery.

RECOMMENDATIONS

It is recommended that:

1. The State Legislatures of Nebraska and North Dakota enact water pollution control legislation of a comprehensive nature.

2. Adequate funds be made available by each State legislature to permit procurement of sufficient personnel for development of comprehensive water pollution control programs.

3. The responsible water pollution control agencies adopt a comprehensive pollution control program to safeguard water quality in the Central Missouri Basin.

4. Sewage and industrial waste treatment needs listed in table 1 be installed at the respective municipalities or industries.

5. State legislatures and municipal authorities recognize the need for competent operation of waste and sewage treatment works in order to insure the efficient utilization of existing and potential treatment facilities. Adequate training and a reasonable insurance of longevity in position would greatly improve operation at most facilities.

GENERAL DESCRIPTION

Historical Background

The early history of the Basin is concerned with the Indians who lived along the banks of the Missouri and its tributaries; the Grand, Moreau, Cheyenne, Bad, and White Rivers. They were primarily hunters and trappers, and were constantly engaged in warring among themselves and against the early white settlers. The most famous tribe was the Dakota Sioux.

The Verendrye Expedition in 1738 was the first recorded visit of the French to what is now known as South Dakota. The Verendrye Brothers reached the village of the "Mantannes" on the Missouri and made a formal claim of the country for the French Government who held dominion until 1763 when they transferred title to Spain. Voyagers, trappers, explorers, scientists, and soldiers traveled throughout the region. During that period commercial activities were largely connected with the fur trade. The Missouri and its tributaries were main highways and also provided habitation along their courses for fur-bearing animals which yielded highly prized pelts for the European trade.

In 1800 the area was retroceded to France, and in 1803 the United States acquired title through the Louisiana Purchase. During the following year an expedition under the direction of Lewis and Clark explored the Missouri system. Following the return of the Lewis and Clark Expedition in 1806 American fur traders took over the region

and remained in control until the decline of the fur trade in the middle of the 19th century. By that time the area had become dotted with trading posts.

In 1831 the steamboat "Yellowstone" arrived at the site of Fort Pierre to introduce steamboat navigation to the upper Missouri and stimulated the fur trade. Fort Pierre, established in 1832, became the leading trading post of the American Fur Company in the northwest.

The discoveries of gold in Idaho and Montana induced a rush of gold seekers through the Basin; however, when the Indians closed the overland trails, the Missouri and its tributaries became the principle routes to the gold fields. Development in the Basin was retarded by Indian disturbances, severe droughts and grasshopper plagues. Steamboating flourished on the Missouri, but the lack of land transportation facilities hampered agricultural activity and many settlers left, never to return.

The report of the Custer Expedition corroborated the belief that gold existed in the Black Hills. The region was opened to the influx of miners when the government was unable to reach an agreement with the Indians in negotiations for a relinquishment of Indian title to the area. Freight and stage lines with terminals at Cheyenne, Wyoming; Sidney, Nebraska; Bismarck, North Dakota; and Fort Pierre, South Dakota; provided transportation to the gold fields. The rush of prospectors and tradesmen which started in the winter of 1875-1876 reached a peak in 1877. The original Homestake Mining Claim was located in April 1876 near Deadwood, South Dakota.

After the excitement of the Black Hills gold rush subsided a more stable settlement began. A liberal land policy, construction of improved transportation facilities, and a period of favorable weather conditions combined to attract many settlers, although subsequent recurring droughts caused agricultural setbacks and made frequent economic adjustments necessary. Mining and cattle grazing became the chief occupations in the western part of the Basin. The processing of agricultural products and minerals constitute the principal manufacturing industry.

Physical Description

The Basin (map No. 1), 64,320 square miles in area, includes 14,400 square miles along the main stem of the Missouri River from Spring Creek to the Niobrara River, exclusive of the drainage areas of the main tributaries. The river flows south from Spring Creek in north central South Dakota to Pierre, South Dakota, where it turns and flows in a southeast direction to its confluence with the Niobrara River. The length of the main stem in this Basin is estimated at 430 miles.

The Basin is characterized by the peculiar shape of the valleys of the Missouri River and its major tributaries, the Grand, Moreau, Cheyenne, Bad, and White Rivers. Land adjacent to these valleys rises abruptly several hundred feet to plains or plateaus. The land east of the Missouri River was glaciated.

The Basin has no extensive lakes or large streams other than the Missouri River. The outstanding topographic features of the Basin are the Black Hills and the Badlands of South Dakota.

Elevations vary from less than 2,000 feet in the lower regions of the Basin to over 7,000 feet in the Black Hills. In general the rivers rise at comparatively low elevations and their runoff is affected by snow melt during the spring. During the other seasons runoff is excessive after heavy rainfall, but flows are otherwise absent in many streams. Table 12 appendix A indicates low flows and the probable frequency of their occurrence.

The average annual precipiation is about 18 inches. The annual mean temperature is about 46° F. with extremes which range from -40° F. in the winter to 115° F. in the summer. The mean monthly temperature for the coldest month, January, is 16° F. and that for the hottest, July, is 75° F.

The Missouri has a gradient of about one foot per mile and carries silt in great quantities down a channel which is generally well defined. Fluctuations in flow result in the formation of mud bars along the stream.

The Grand River Sub-Basin comprises an area of approximately 5,700 square miles. The North and South Forks of the Grand River and their tributaries rise at elevations of about 3,000 feet. The land elevation is about 1,600 feet near the confluence of the Grand and Missouri Rivers. The Grand River has an average channel slope of five feet per mile. The area is largely composed of plains and plateaus broken occasionally by buttes and hills. Streams in the Sub-Basin meander through narrow valleys which are frequently subjected to damaging flash floods.

The Moreau Sub-Basin has a drainage area of about 5,400 square miles. It rises in northwestern South Dakota at an elevation of slightly more than 3,000 feet and flows eastward. The Moreau River meanders through narrow valleys, flanked by high rolling prairies; the gradient of the river is slight.

The Cheyenne Sub-Basin is roughly wedgelike in shape, and includes the northeastern corner of Wyoming, the southwestern corner of South Dakota, the northwestern corner of Nebraska and the area through central South Dakota to the Missouri River. The Sub-Basin varies from 40 to 180 miles in width and has a total area of 25,500 square miles. The South Fork of the Cheyenne River rises in the plains country of northeastern Wyoming and flows eastward through Wyoming and northeast through South Dakota, passing south and southeast of the Black Hills to its junction with the Belle Fourche River near Gumbo in west central South Dakota. The Belle Fourche River, principal tributary of the Cheyenne, rises in the plains of northeastern Wyoming and flows northeast to within a few miles of the Wyoming-Montana State line where it turns sharply southeast to flow around the northern border of the Black Hills and through South Dakota to its junction with the South Fork of the Cheyenne River. The Cheyenne River then flows generally northeast to its confluence with the Missouri River.

The plains country of northeastern Wyoming and central South Dakota is generally similar and consists of heavily rolling country rising from the streams in a series of benches or terraces, broken by buttes and occasional badlands. The latter is a region of rough, broken and irregular topography which has been eroded from shales and clays into fantastic forms almost devoid of vegetation.

The Black Hills range from 3,000 to 7,000 feet in elevation. Streams are typical torrential mountain watercourses with narrow valleys and occasional canyons; slopes are steep and rapids and falls are common. The mean annual precipitation east of the Black Hills is 15 inches. At Oelrichs, South Dakota, it is about 18 inches; and at Dowling, South Dakota, about 17 inches. West of the Black Hills precipitation is less and averages only about 10 inches annually. In the Black Hills the mean annual precipitation is about 23 inches. Snowfall varies from 30 to 98 inches with an annual average of 48 inches. Temperature ranges from -42° F. to 110° F. have been recorded with annual averages of about 47° F. The growing season varies from an average of about 125 days in the Black Hills to 144 days on the plains.

Heavy snowfall throughout the Cheyenne River Sub-Basin affects spring runoff. The snow melt which begins early in the spring continues until June in the Black Hills. The rainfall peak occurs in June or July; thereafter the precipitation decreases and is low in the autumn and winter. In the Sub-Basin of the Belle Fourche River the spring peak occurs from one to two months earlier. Black Hills tributaries flow throughout the year; however discharges are very small in the late fall and early winter. In the extreme western part of the Sub-Basin the main streams are almost dry during July through September.

The Cheyenne Sub-Basin is subject to heavy rains and cloudbursts over small areas, causing frequent local floods; heavy rains falling throughout the Basin have caused floods on the Missouri River.

The Bad River, formed by the junction of Cottonwood and Big Buffalo Creeks in west central South Dakota, flows generally northeasterly 139 miles to its junction with the Missouri River at Ft. Pierre, South Dakota, and has a drainage area of about 3,120 square miles. The average slope of the river is about 6 feet per mile. The western portions of the Sub-Basin are characterized by badlands and the eastern portions are upland plains through which the streams flow in a narrow valley. The entire Sub-Basin is located in the unglaciated portion of the plateau region and the high plains section. In the upland plains the Bad River meanders through narrow valleys not exceeding one and one-half miles in width. The river and its tributaries have entrenchments varying from 100 to 500 feet below the adjacent plains. Occasionally buttes rise 250 to 500 feet above the adjacent upland plain.

The Bad River is a typical plains stream, with a large portion of the annual runoff occurring in the spring months. Moisture is not retained by the clayey soils of the Sub-Basin, therefore late spring, summer, and fall flows are negligible except at time of precipitation. Stream discharges vary from zero to flood proportions.

The White River watershed, with an area of 10,200 square miles, lies between the Bad River in South Dakota and the Niobrara River in Nebraska. The headwaters of the river lie in northwestern Nebraska and flow generally northeastward 507 miles to a point south of Oacoma, South Dakota, where it joins the Missouri River. The stream has an average slope of over six feet per mile. Badlands in the South Dakota sections characterize the Sub-Basin; in the east, upland plains are cut by the meandering stream which flows through a narrow valley. The principal tributary, the Little White River, rises about 10 miles north of the South Dakota-Nebraska line, flows east to the vicinity of St. Francis, South Dakota, and from that point to the White River near Westover, 123 miles above the mouth of the White. Most of the Sub-Basin lies in the unglaciated portion of the Missouri Plateau. Headwaters of the White and Little White are in the high plains but both break through the Pine Ridge escarpment into the Missouri plateau.

The White River rises at an elevation of 4,500 feet. The Little White River rises at an elevation of 3,500 feet. After leaving the high plains the White River flows down a comparatively wide and fertile valley to the South Dakota line; thereafter the stream advances through the "Big Badlands" at elevations of about 3,500 feet. The valley is narrow and the stream follows a meandering route. The channel is 100 to 500 feet below the surrounding plains country. Throughout the area buttes rise from 250 to 500 feet above the adjacent surfaces.

Economic Development

Economic development began with the French fur traders. Interest in the region grew steadily. After the turn of the 19th century and the completion of the "Louisiana Purchase" American fur traders continued the profitable business.

The 1850s brought many new developments, including the formal organization of the Dakota Territory. The discovery of gold in the Rocky Mountain region provided considerable impetus for development. The need for transportation was met by the operation of steamboats and the construction of railroads. In 1880 the Northwestern Railroad reached the Missouri River at Pierre, South Dakota, and the Chicago, Milwaukee & St. Paul reached Chamberlain, South Dakota. In 1885 and 1886 the construction of a railway line from Chadron, Nebraska, to Rapid City, South Dakota, helped in the development of the Black Hills area.

Railroad lines were built from Pierre and Chamberlain to Rapid City in 1906 and 1907. The Chicago, Milwaukee & St. Paul built lines from Mobridge to Lemmon in 1909 and to Isabel and Faith shortly thereafter. The Northwestern Railroad Company built a line from Bonesteel to Winner in the Rosebud region between 1907 and 1911.

By 1900 economic conditions were vastly improved. The price level was curving upward and weather conditions became more favorable. The introduction of drought resistant plants, particularly the alfalfas and durum wheat, were a boon to agriculture. The Belle Fourche Valley Development Project, sponsored by the Bureau of Reclamation, was finished in 1907. Indian lands were opened for settlement in the

Table 2. Central Missouri Basin - Population of municipalities

Municipality	State	Population U. S. Census 1920	1930	1940	1950
Grand River Sub-Basin					
Bowman	North Dakota	767	888	967	1,382
Bucyrus	North Dakota	113	124	117	111
Gascoyne	North Dakota	60	97	48	76
Haynes	North Dakota	113	167	210	145
Hettinger	North Dakota	817	1,292	1,138	1,762
Reeder	North Dakota	258	395	263	339
Rhame	North Dakota	302	354	283	340
Scranton	North Dakota	212	204	277	360
McIntosh	South Dakota	727	663	626	624
Buffalo	South Dakota	-	-	518	372
Moreau River Sub-Basin					
Dupree	South Dakota	213	365	460	434
Eagle Butte	South Dakota	210	387	374	373
Isabel	South Dakota	240	430	490	505
Timber Lake	South Dakota	555	572	512	553
Red River Sub-Basin					
Belvidere	South Dakota	-	214	187	171
Cottonwood	South Dakota	121	191	118	101
Kadoka	South Dakota	341	385	464	583
Midland	South Dakota	309	262	282	383
Philip	South Dakota	647	786	833	805
Quinn	South Dakota	-	141	189	214
Cheyenne River Sub-Basin					
Ardmore	South Dakota	220	261	195	108
Belle Fourche	South Dakota	1,616	2,032	2,496	3,517
Central City	South Dakota	199	198	302	219
Custer	South Dakota	595	1,203	1,845	2,019
Deadwood	South Dakota	2,403	2,559	4,100	3,270
Edgemont	South Dakota	1,254	1,103	1,002	1,151
Faith	South Dakota	575	607	522	592
Fruitdale	South Dakota	40	113	89	68
Hot Springs	South Dakota	2,141	3,486	4,083	4,980
Lead	South Dakota	5,013	5,733	7,520	6,419
Newell	South Dakota	414	547	683	776
New Underwood	South Dakota	164	311	214	266
Nisland	South Dakota	173	187	212	216
Oelrichs	South Dakota	-	206	212	166
Rapid City	South Dakota	5,777	10,404	13,844	25,177
Spearfish	South Dakota	1,254	1,577	2,139	2,570
Sturgis	South Dakota	1,250	1,747	3,008	3,461
Wall	South Dakota	224	326	500	556
Wasta	South Dakota	-	-	153	144
Whitewood	South Dakota	339	392	267	304
Gillette	Wyoming	1,157	1,340	2,177	2,191
Moorcroft	Wyoming	420	341	387	517
Newcastle	Wyoming	1,003	1,201	1,962	3,395
Sundance	Wyoming	328	369	685	893
Upton	Wyoming	306	373	545	951
Main Stem Missouri River Sub-Basin					
Akaska	South Dakota	101	169	151	83
Avon	South Dakota	630	670	728	690
Blunt	South Dakota	512	477	322	417
Chamberlain	South Dakota	1,303	1,364	1,626	1,912
Dante	South Dakota	175	132	118	139
Eureka	South Dakota	-	-	1,457	1,576
Geddes	South Dakota	695	680	581	502
Gettysburg	South Dakota	951	1,400	1,324	1,550
Glenham	South Dakota	135	187	131	164
Harrold	South Dakota	252	309	229	259
Java	South Dakota	527	529	493	433
Kennebec	South Dakota	341	349	390	372
Kimball	South Dakota	-	-	997	952
Lake Andes	South Dakota	867	1,052	785	1,844
Lowry	South Dakota	-	89	90	70
Mobridge	South Dakota	3,517	3,464	3,008	3,747
Oacoma	South Dakota	224	167	197	231
Pierre	South Dakota	3,209	3,659	4,322	5,690
Platte	South Dakota	1,242	1,207	1,017	1,070
Presho	South Dakota	626	487	568	708
Pukwana	South Dakota	192	307	258	298
Ravinia	South Dakota	199	157	155	200
Reliance	South Dakota	317	287	219	216
Stickney	South Dakota			361	388
Wagner	South Dakota	1,236	1,420	1,319	1,518
McLaughlin	South Dakota	555	678	660	711
White River Sub-Basin					
Carter	South Dakota	105	89	42	-
Interior	South Dakota	-	144	182	123
Martin	South Dakota	-	720	1,013	988
Murdo	South Dakota	500	619	680	737
White River	South Dakota	417	471	562	465
Winner	South Dakota	2,000	2,220	2,486	3,239
Witten	South Dakota	204	307	9	-
Wood	South Dakota	-	257	414	256
Chadron	Nebraska	4,412	4,606	4,262	4,687
Crawford	Nebraska	1,646	1,703	1,845	1,824
Harrison	Nebraska	401	480	500	492

period 1904-1915. The boom was interrupted by an intense drought in 1910 and 1911; however, favorable weather conditions after 1911, combined with the increased use of power machinery and the stimulation furnished by World War I, resulted in another agricultural boom. Adverse conditions appeared again in 1920 in the form of low prices, drought, and grasshopper plagues. These conditions, coupled with the tendency to cultivate areas unsuited for crop farming, resulted in serious economic retrogression which was reflected by a sharp decline in population, and large relief rolls. As a result, the residents of the region have realized that efficient water and land conservation policies are required if the economy and population are to be stabilized.

The raising of livestock is the principal source of farm income. About 70 percent of the value of agricultural products is from livestock and related products; 14 percent is from crops such as wheat, corn, truck farming and alfalfa. Natural resources include deposits of manganese, lignite, bentonite, gold and feldspar. Lithium, tin, and mica are also found. The Homestake Mine is one of the world's most productive gold mines. Rich oil and gas fields have been developed in the Wyoming section of the Basin.

The tourist industry has been a very important development. Points of interest include Deadwood with its museum of pioneer relics, its graves of Calamity Jane, Wild Bill Hickok, and Preacher Smith; its towering white rocks and its Roosevelt monument. The second largest gold mine in the world is located between Lead and Deadwood. The scenery of the southern Black Hills includes Harney Peak (elevation 7,242 feet), Sylvan and Stockade Lakes, and the Mount Rushmore Memorial. The streams provide excellent fishing and contribute significantly to the scenic grandeur.

Railroads, highways, airways and modern communication systems now serve the area. Census data indicate that an over-all population increase of about 23 percent has occurred in the cities and towns listed in table 2 during the 1940-50 period. Much of the gain has registered in the cities of 2,000 population and above. Many of the smaller municipalities have declined in size.

USES OF WATER RESOURCES

Surface water resources are utilized principally for irrigation, stockwatering, fishing, and hydroelectric power development. Ground waters remain as the chief source of supply for municipal, domestic, and industrial users.

Eighty-seven communities in the Basin have waterworks supplying ten million gallons of water daily to about 100,000 people. Approximately 84 percent of the people are using water from ground sources (table 3). Thirteen municipalities obtain their water supplies for surface reservoirs or streams (table 4). Only in the White River Sub-Basin does surface water supply the needs of more municipal residents than does ground water. No municipalities use surface waters in the Grand River, Moreau River, and Bad River Sub-Basins. It is anticipated, however, that greater usage of surface water for

domestic purposes will occur as the land and water resource development program of the Basin reaches completion. Ground waters usually contain excessive solids, sulphates, alkalinity, hardness, iron, and magnesium, and generally do not meet water quality standards established by the Public Health Service Drinking Water Standards for potable waters on interstate carriers.

The streams of South Dakota have been divided into two classes. Class A streams must be protected from pollution, but Class B streams have as their principal function the transportation and ultimate disposal of wastes. One stream, Whitewood Creek, has been so classified. The other States of the Basin have not classified their streams. The growth of cities and industry is reflected in the increasing usage of the stream waters as a means of waste disposal. This valuable attribute of a flowing stream must be guarded through control of the quantity and kind of wastes entering it, or it may become a serious liability.

Industry has become a major user of water for processing, cooling, washing, and air conditioning. Those industries requiring large volumes of water include the oil refineries, sugar beet refineries, and packing houses. Industrial water consumption in this region is undetermined, however it probably equals or exceeds the domestic uses.

The use of water for irrigation has become one of its most important functions in the region since the opening of the Belle Fourche irrigation project in 1908. In 1948, 39,000 acres of the project were under irrigation. A tract of about 10,000 acres was opened to irrigation in 1922 near Whitney, Nebraska. Several other smaller areas, particularly along Rapid Creek east of Rapid City, South Dakota, and near Sundance and Newcastle, Wyoming, are now being irrigated. Irrigation will undoubtedly expand with the development of the additional reservoirs. It is anticipated that more than 100,000 acres will be brought under irrigation in the near future.

The development of hydroelectric power has materially aided gold mining operations, oil refining and local industry within the Basin. Four hydroelectric power plants utilizing run of the river flow form a part of an interconnected system lying within the Black Hills region. The electrical power supply for Hot Springs, South Dakota, obtained from a hydroelectric plant on Fall River, is not a part of the interconnected system. There is also one small hydroelectric plant operating at White River, South Dakota. A hydroelectric plant has been constructed in conjunction with Angostura Dam to produce power for pumping water to irrigate approximately 42,000 acres of nearby land.

Three major dams, Oahe, Big Bend, and Fort Randall on the main stem of the Missouri, will produce firm power. Oahe, now under construction, will have an installed capacity of 425,000 kilowatts; Big Bend, 120,000 kilowatts; and Fort Randall, also under construction, 320,000 kilowatts. The average future annual generation capacity of the combined plants is estimated at 3,500,000,000 kilowatt-hours. Besides producing electrical power, the Oahe and Fort Randall Reservoirs will serve their prime purposes of supplying water for navigation in the lower Missouri River and for controlling floods in the

Table 3. Central Missouri Basin - Municipal water supplies from ground sources

Municipality	State	Source	Treatment		Population Served	Average Consumption M.G.D.
Main Stem - Missouri River						
Agar	S. D.	W	N		100	0.026
Armour	S. D.	W	N		995	0.08
Avon	S. D.	W	N		728	0.03
Bowdle	S. D.	W	N		680	0.03
Blunt	S. D.	W	N		322	0.01
Gorsica	S. D.	W	N		360	0.02
Cheyenne Agency	S. D.	W	N		600	0.03
Delmont	S. D.	W	N		230	0.015
Eureka	S. D.	W	N		1,095	0.05
Geddes	S. D.	W	N		581	0.04
Gettysburg	S. D.	W	N		1,324	0.05
Harrold	S. D.	W	D		230	0.03
Java	S. D.	W	N		375	0.03
Kennebec	S. D.	W	N		300	0.018
Kimball	S. D.	W	N		880	0.046
Lake Andes	S. D.	W	N		600	0.02
McLaughlin	S. D.	W	N		660	0.15
Oacoma	S. D.	W	N		197	0.006
Onida	S. D.	W	N		565	0.15
Pierre	S. D.	W	N		4,382	0.40)
Pierre Indian School	S. D.				500	)
Platte	S. D.	W	N		1,017	0.04
Presho	S. D.	W	N		455	0.025
Fukwana	S. D.	W	N		258	0.015
Ravinia	S. D.	W	N		140	0.008
Reliance	S. D.	W	N		219	0.01
Selby	S. D.	W	N		1,095	0.04
Wagner	S. D.	W	N		1,319	0.20
White Lake	S. D.	W	N		850	0.015
				TOTAL	22,312	1.654
Grand River Basin						
Bowman	N. D	W	N		967	0.038
Mottinger	N. D.	W	N		1,138	0.040
Rhame	N. D.	W	N		283	0.004
Scranton	N. D.	W	N		277	0.100
				Sub-total	2,665	0.182
Buffalo	S. D.	W	N		250	0.015
McIntosh	S. D.	W	N		626	0.030
Trail City	S. D.	-	-		200	0.012
				Sub-total	1,076	0.057
				TOTAL	3,741	0.239
Moreau River Basin						
Timberlake	S. D.	W	N		512	0.03
Bad River						
Belvidere	S. D.	W	D		140	0.02
Ft. Pierre	S. D.	W	N		764	0.04
Kadoka	S. D.	W	N		464	0.02
Midland	S. D.	W	N		282	0.06
Philip	S. D.	W	N		831	0.06
				TOTAL	2,481	0.20
White River Basin						
Interior	S. D.	W	N		182	0.002
Martin	S. D.	W	N		1,013	0.100
Pine Ridge	S. D.	W	N		1,200	0.060
Rosebud Indian Agency	S. D.	W	N		350	0.020
White River	S. D.	W	D		550	0.033
Winner	S. D.	W	D		2,426	0.150
Harrison	Nebr.	W	N		500	0.06
Whitney	Nebr.	W	N		154	0.015
				TOTAL	6,375	0.440
Cheyenne River Basin						
Belle Fourche	S. D.	S	N		2,496	0.400
Buffalo Gap	S. D.	W	N		175	0.005
Custer	S. D.	W	N		1,845	0.300
Deadwood	S. D.	S	D		4,100	0.500
Edgemont	S. D.	W	D		900	0.054
Fruitdale	S. D.	W	N		89	0.008
Hermosa	S. D.	W	N		100	0.010
Hot Springs	S. D.	S	DA		4,083	0.360
Lead	S. D.	S	D		7,520	0.450
Central City	S. D.	Served by Lead				
Nisland	S. D.	W	N		212	0.020
Oelrichs	S. D.	W	N		170	0.008
Rapid City	S. D.	W & S	D		13,844	2.75
Sanator TB Hospital	S. D.	W & S	D		250	0.025
Spearfish	S. D.	S	D		2,139	0.080
Sturgis	S. D.	S	N		3,008	0.100
Hill City	S. D.	W	D		300	-
Wasta	S. D.	S	N		153	0.001
Whitewood	S. D.	S	N		867	0.030
Gillette	Wyo.	W	D		2,177	0.03
Lance Creek	Wyo.	W	D		676	0.07
Moorcroft	Wyo.	W	N		387	0.02
Newcastle	Wyo.	W	N		1,962	0.20
Sundance	Wyo.	S	N		685	0.04
Upton	Wyo.	W	N		545	0.50
				TOTAL	48,083	5.961

Source - W - Wells
S - Springs

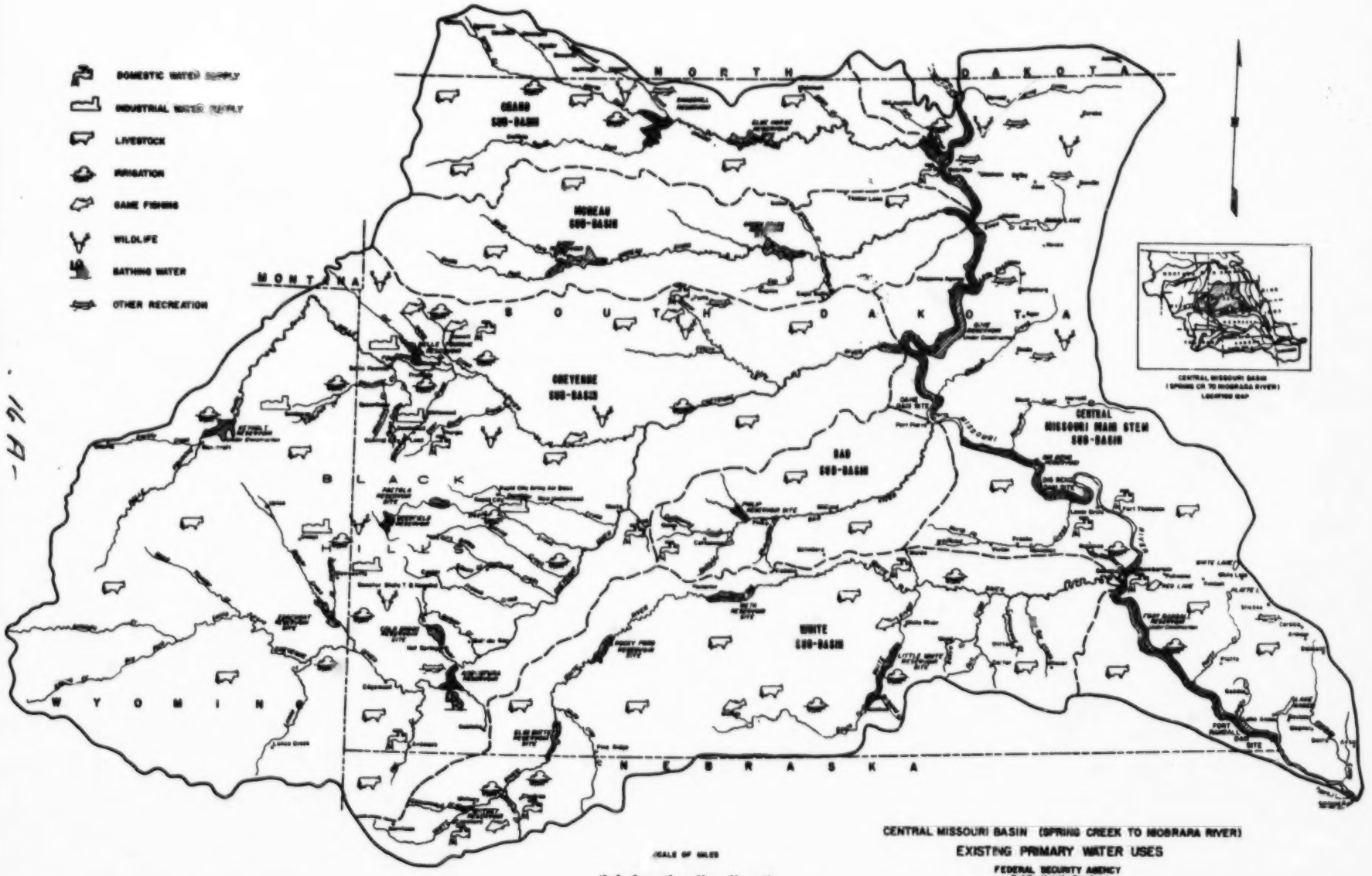
Treatment - N - None
D - Chlorinated
A - Aeration

Table 4. Central Missouri Basin - Municipal water supplies from surface sources

Municipality	State	Sub-Basin	Source	Treatment	Population served	Average Consumption M.G.D.
Ardmore	S. D.	Cheyenne River	Hot Creek Lake	N	145	0.009
Faith	S. D.	Cheyenne River	Impoundment	FD	500	0.060
Newell	S. D.	Cheyenne River	Irrigation Ditch	F	683	0.03
Sturgis*	S. D.	Cheyenne River	Bear Butte	D	3,008	0.10
Wall	S. D.	Cheyenne River	Impoundment	~~F~~ F.D.	500	0.014
Quinn	S. D.	Bad River	Impoundment	N	180	0.015
Murdo	S. D.	White River	Impoundment	FD	680	0.02
Crawford	Nebr.	White River	Impoundment	FD	1,845	0.18
Chadron	Nebr.	White River	Deadman's Creek	FD	4,262	0.25
Chamberlain	S. D.	Missouri	Missouri River	FD	1,626	0.250
Ft. Thompson	S. D.	Missouri	Missouri River	FAD	500	0.020
Mobridge	S. D.	Missouri	Missouri River	FD	3,008	0.250
Lower Brule	S. D.	Missouri	Missouri River	FAD	100	0.006

*Uses ground sources to supplement surface supplies.

Treatment - N - None
F - Coagulated, Settled, Filtered
D - Chlorinated
A - Aerated
H - Softened



CENTRAL MISSOURI BASIN (SPRING CREEK TO NIOBRARA RIVER)

EXISTING PRIMARY WATER USES

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO 2

-12-

lower Missouri and middle Mississippi Rivers. Attending benefits, include the reduction of silt and the creation of recreational facilities. Additional flood control reservoir sites in the Black Hills are being investigated by the Corps of Engineers (table 13, appendix A).

The extreme paucity of surface water throughout the Basin, with the exception of the Black Hills, has made that which is available very attractive to local recreational interests. Hidden Wood, Molestead, Flat Creek, Scully, Corsica, Durkee, Campbell and Hurley Lakes and Lake Andes are popular recreational areas and are utilized intensively by local residents for picnicking, hunting, and fishing. All these lakes are within the State of South Dakota outside the region of the Black Hills. There are several streams and lakes within the Black Hills area which provide excellent fishing besides being very important adjuncts to the scenic value of the area. The Belle Fourche Reservoir has a history of good and bad fishing years, however the absence of plentiful fishing grounds in South Dakota attracts fishermen to it from a wide area.

A fish hatchery is maintained at Crawford, Nebraska, for stocking local ponds and lakes with trout. The main stem of the White River below Chadron, Nebraska, is unsuitable for trout because of domestic and industrial pollution and its erratic flow.

None of the streams of the Basin is considered navigable except the main stem of the Missouri River, and it has been used very little in recent years. Principal water uses are shown on map 2.

POLLUTION CONTRIBUTED TO WATER RESOURCES

There are 58 sources of municipal pollution in the area encompassed by this report. Approximately 103,000 people contribute to sewerage systems. Installed treatment removes approximately 46 percent of the pollutional material prior to its discharge into streams. In addition to sewage from municipal systems, 8 industries discharge waste products directly to streams.

Twenty-four municipalities provide primary treatment for sewage originating from approximately 21,000 people. Nineteen municipalities provide secondary treatment of sewage waste from approximately 49,000 people. Fifteen municipalities, in which more than 33,000 people reside, contribute untreated wastes. Municipalities that discharge untreated wastes include Lead, Deadwood, Belle Fourche, Edgemont, Fort Pierre, Avon, Chamberlain, Cheyenne Agency, Eureka, Fort Thompson, Geddes, Lake Andes, Mobridge and Pierre, South Dakota; and Newcastle, Wyoming.

Industrial wastes originate largely from oil refineries at Osage, Newcastle, and Sundance, Wyoming; from the sugar refinery at Belle Fourche, and the Homestake Gold Mine at Lead, South Dakota. The largest industry is the beet sugar refinery which produces waste with a population equivalent of 190,000. Beet sugar refining is a seasonal operation lasting about three months. Six of the remaining industries

are engaged in oil production and refining. The wastes released from these operations are a mixture of organic and inorganic materials. The petroleum industry is centered in the northeastern part of Wyoming where only small streams are available for receiving wastes. White Wood Creek has been declared a Class B stream by the South Dakota Committee on Water Pollution. Thus the creek's designated prime function is to carry away rock flour and other wastes incurred in production of gold at the Homestake Mines. Two municipalities, Lead and Deadwood, South Dakota, also discharge their wastes into White Wood Creek without treatment. There is some oil waste from the Lance Creek Oil Field draining into Lance Creek.

Tables 5 and 6 list the sources of municipal and separately discharged industrial wastes together with other pertinent information. These sources are indicated on maps 3 and 4.

DAMAGES TO WATER RESOURCES FROM POLLUTION

Most of the damages to water resources occur below the larger municipalities or industries. The Belle Fourche River below the Utah and Idaho Sugar Beet Refinery near Belle Fourche, South Dakota, is polluted by sewage from Belle Fourche and wastes from the sugar beet refinery. The Fish and Wildlife Service reports that the fishery value of the river has been adversely affected for a distance of some 25 to 30 miles. Flows in the river during the sugar beet campaign are usually very low or nonexistent, thus adding to the problem of controlling the industrial pollution.

About 20 miles east and downstream from the City of Belle Fourche the Belle Fourche River receives, via White Wood Creek, rock flour and other inorganic polluting materials originating from the Homestake Gold Mine operations near the headwaters of the creek. The carry-over of inorganic pollution from White Wood Creek has resulted in curtailment of biological activity in the Belle Fourche River for a considerable distance below the mouth of the creek.

Discharges from storm sewers into which household sewers have been connected, together with sewage from individual residences bordering Rapid Creek within Rapid City, South Dakota, have resulted in a potentially dangerous pollution condition in and below the city. It is anticipated that this condition will be corrected when proper sewage collection facilities can be constructed for that section of the city not now properly sewered.

Inadequately treated sewage from Chadron, Nebraska, and wastes from a nearby oil refinery have led to rather serious pollution of Chadron Creek and a short reach of the White River. The oil refinery attempts to provide treatment for removal of oil. However some oils, together with acids, caustics, mercaptans, nitrogen and sulphur compounds, lead, suspended solids, phenols, and dissolved gasses reach the stream in sufficient quantities to produce an undesirable condition.

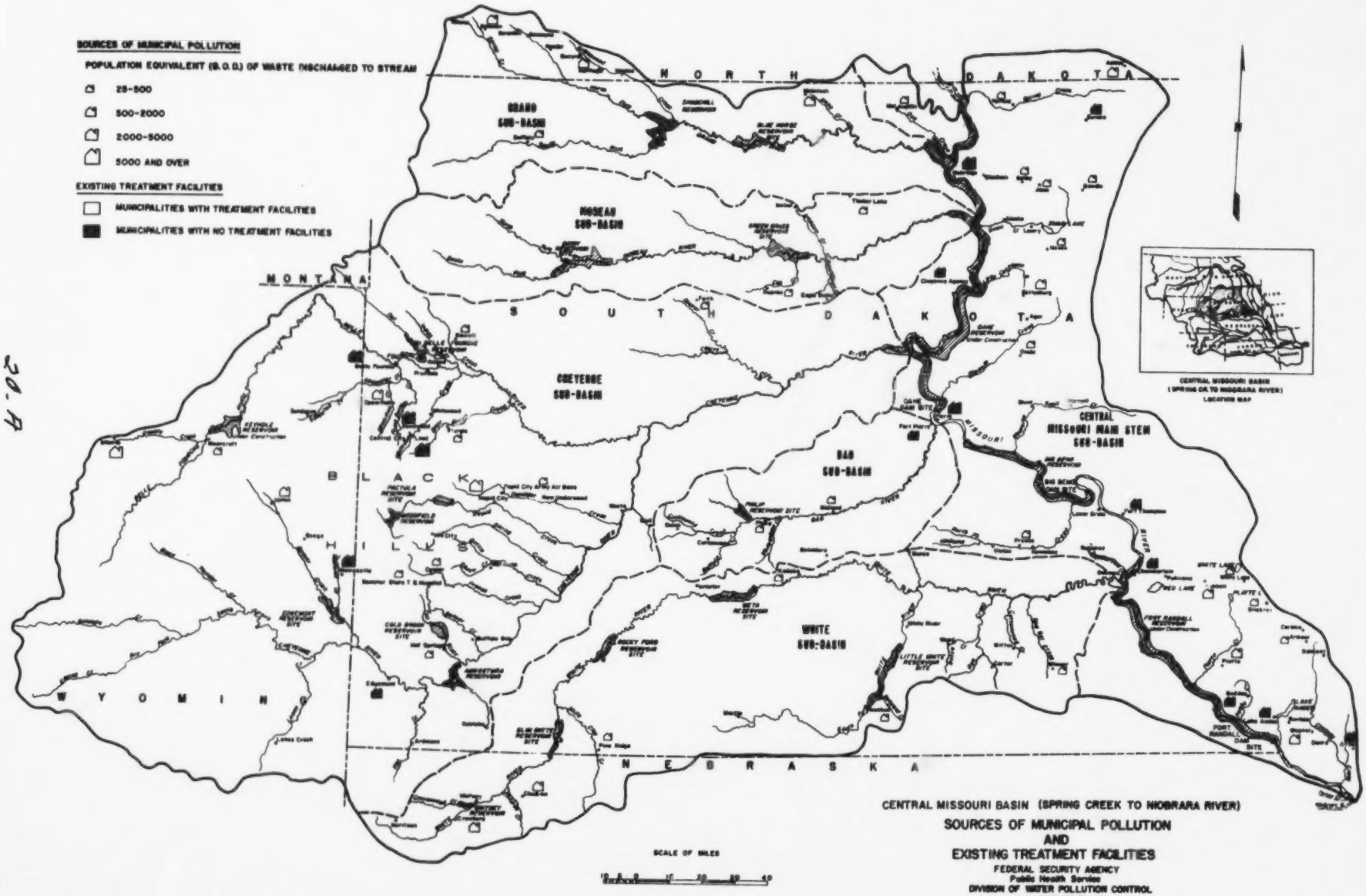
Table 5. Central Missouri Basin - Basic data on sources of municipal pollution

Name and location of municipality	Sewered population	Estimated untreated waste population equivalent	Treatment provided	Adequacy of treatment		P. E. Discharged (est.)	Treatment needs	Community action
				Cap'y	Oper.			
Missouri River								
Spring Creek								
Land Locked								
Ashley, N.D.	1,500	1,500	Primary	Satisf.	Satisf.	1,000	None	
Eureka, S. D.	1,200	1,200	None	-	-	1,200	New plant	Inactive
Herreid, S. D.	600	600	Primary	Satisf.	Satisf.	400	None	
Oak Creek								
McLoughlin, S. D.	650	650	Primary	Satisf.	Satisf.	450	None	
Grand River								
North Fork Grand River								
Spring Creek								
Bowman, N.D.	890	890	Primary	Unsat.	Satisf.	625	Enlargement	Inactive
South Fork Grand River								
Buffalo, S.D.	370	370	Primary	Satisf.	Satisf.	-	None	
Hidewood Creek								
Bettinger, N.D.	1,600	1,600	Septic tank	Unsat.	Unsat.	1,440	New plant	Inactive
Stink Creek								
McIntosh, S.D.	750	750	Primary	Satisf.	Satisf.	500	None	
Mobridge, S. D.	3,000	3,500	None	-	-	3,500	New plant	Inactive
Moreau River								
Tributary								
Timber Lake, S.D.	575	575	Secondary	Satisf.	Unsat.	150	None	
Elm Creek								
Dupree, S.D.	400	400	Secondary	Satisf.	Satisf.	80	None	
Bush Creek								
Selby, S.D.	600	600	Primary	Satisf.	Unsat.	400	None	
Java, S.D.	60	60	Primary	Satisf.	Satisf.	40	None	
Bowdle, S.D.	700	700	Primary	Unsat.	Unsat.	490	Enlargement	Inactive
Cheyenne Agency, S.D.	1,200	1,200	None	-	-	1,200	New plant	Inactive
Cheyenne River								
Beaver Creek								
Upton, Wyo.	600	600	Primary	Unsat.	Unsat.	600	Enlargement	Inactive
Blacktail Creek								
Newcastle, Wyo.	3,300	3,300	None	-	-	3,300	New plant	Plans approved
Edgemont, S.D.	900	900	None	-	-	900	New plant	Inactive
Fall River								
Hot Springs, S.D.	5,000	5,000	Secondary	Satisf.	Satisf.	450	None	
Beaver Creek								
Senator Pratt T.B. Hospital, S.D.	300	300	Secondary	Satisf.	Satisf.	60	None	
French Creek								
Custer, S.D.	3,500	3,500	Secondary	Satisf.	Satisf.	350	None	
Rapid Creek								
Rapid City, S.D.	25,000	26,600	Secondary	Unsat.	Satisf.	2,260	Enlargement	Under construction
Box Elder Creek								
Rapid City Army Air Base, S.D.	500	500	Secondary	Satisf.	Satisf.	50	None	
Belle Fourche River								
Donkey Creek								
Gillette, Wyo.	2,200	2,200	Primary	Unsat.	Unsat.	2,200	Replacement	Inactive
Moorcroft, Wyo.	300	300	Primary	Unsat.	Unsat.	150	Enlargement	Inactive
Belle Fourche, S.D.	2,500	3,000	None	-	-	3,000	New plant	Inactive
Red Water Creek								
Spearfish Creek								
Spearfish, S.D.	2,200	2,200	Secondary	Unsat.	Satisf.	550	Enlargement	Inactive
Nisland, S.D.	210	210	Primary	Satisf.	Satisf.	150	None	
Whitewood Creek								
Lead, S.D.	7,500	7,500	None	-	-	7,500	New plant	Inactive
Deadwood, S.D.	4,100	4,100	None	-	-	4,100	New plant	Inactive
Indian Creek								
Newell, S.D.	350	350	Primary	Unsat.	Unsat.	245	Replacement	Inactive
Bear Butte Creek								
Sturgis, S.D.	3,500	3,500	Secondary	Satisf.	Satisf.	170	None	
Cheyenne River								
Cherry Creek								
Beaver Creek								
Faith, S.D.	400	400	Secondary	Unsat.	Satisf.	100	Enlargement	Inactive
Ombole Creek								
Hoven, S.D.	370	370	Secondary	Satisf.	Satisf.	80	None	
Gettysburg, S.D.	1,200	1,200	Primary	Satisf.	Satisf.	800	None	
Onida, S.D.	400	400	Primary	Unsat.	Satisf.	265	Enlargement	Inactive
Pierre, S.D.	4,300	4,500	None	-	-	4,500	New plant	Inactive
Fort Pierre, S.D.	764	775	None	-	-	775	New plant	Inactive
Red River								
Philip, S.D.	650	650	Primary	Unsat.	Unsat.	450	Enlargement	Inactive
White Willow Creek								
Kadoka, S.D.	400	400	Primary	Unsat.	Unsat.	300	Replacement	Inactive
Midland, S.D.	250	250	Primary	Satisf.	Satisf.	175	None	
Medicine Creek								
Presho, S.D.	400	400	Primary	Unsat.	Unsat.	280	Replacement	Inactive
Fort Thompson, S.D.	500	500	None	-	-	500	New plant	Inactive
Chamberlain, S.D.	1,800	1,800	None	-	-	1,800	New plant	Planning initiated
White River								
Crawford, Nebr.	1,700	1,700	Secondary	Unsat.	Satisf.	510	Enlargement	Inactive
Chadron Creek								
Chadron, Nebr.	4,500	4,500	Primary	Unsat.	Satisf.	4,500	New plant	Inactive
White Clay Creek								
Pine Ridge, S.D.	1,000	1,000	Secondary	Satisf.	Satisf.	150	None	
Little White River								
Rosebud, S.D.	350	350	Secondary	Satisf.	Satisf.	50	None	
Dog Ear Creek								
Winner, S.D.	2,000	3,000	Secondary	Satisf.	Satisf.	300	None	
Platte Creek								
White Lake, S.D.	400	400	Secondary	Satisf.	Unsat.	200	None	
Kimball, S.D.	800	800	Primary	Unsat.	Unsat.	600	Replacement	Inactive
Platte, S.D.	1,000	1,000	Secondary	Unsat.	Unsat.	750	Replacement	Under construction
Stickney, S.D.	350	350	Secondary	Sat.	Satisf.	70	None	
Pease Creek								
Geddes, S.D.	600	600	None	-	-	600	New plant	Inactive
Lake Andes Creek								
Lake Andes, S.D.	800	800	None	-	-	800	New plant	Inactive
Choteau Creek								
Armour, S.D.	1,000	1,000	Secondary	Satisf.	Satisf.	400	None	
Wagner, S.D.	1,000	1,000	Primary	Unsat.	Satisf.	800	Enlargement	Inactive
Avon, S.D.	500	500	None	-	-	500	New plant	Inactive

Table 6. Central Missouri Basin - Basic data on sources of industrial pollution

Name and location of industries	Type of industry	Type of waste produced	Treatment or other pollution control measures		Population equivalent discharged to watercourse	Pollution abatement measures needed	Project status
			Degree	Adequacy			
Missouri River							
Cheyenne River							
Lance Creek							
Oil Fields	Petroleum	Organic	Minor	Inadequate	Unkown	Improved control measures	Inactive
Beaver Creek							
Manewal & Bradley Oil Refinery, Osage, Wyo.	Petroleum	Organic & Inorganic	Minor	Inadequate	Unknown	Improved control measures	Inactive
Blacktail Creek							
Carter Oil Refinery	Petroleum	Organic & Inorganic	Minor	Inadequate	Unknown	Enlarge	Inactive
Graco Oil Refinery	Petroleum	Organic & Inorganic	Minor	Inadequate	Unknown	Enlarge	Inactive
Wyoming Gas & Oil Co. Newcastle, Wyo.	Petroleum	Organic & Inorganic	Minor	Inadequate	Unknown	Enlarge	Inactive
Belle Fourche River							
U & I Sugar Refinery Belle Fourche, S.D.	Food & kindred products	Organic	Partial	Inadequate	190,000	New plant or other control measures	Under construction
Red Water Creek							
Sundance Creek							
Crook Co. Oil Refinery Sundance, Wyo.	Petroleum	Organic & Inorganic	Partial	Inadequate	Unknown	Enlarge	Inactive
White Wood Creek							
Homestake Gold Mine Lead, S. D.	Mining	Inorganic	None	-	-	None*	

*White Wood Creek is classified as a Class "3" stream into which untreated wastes may be discharged.

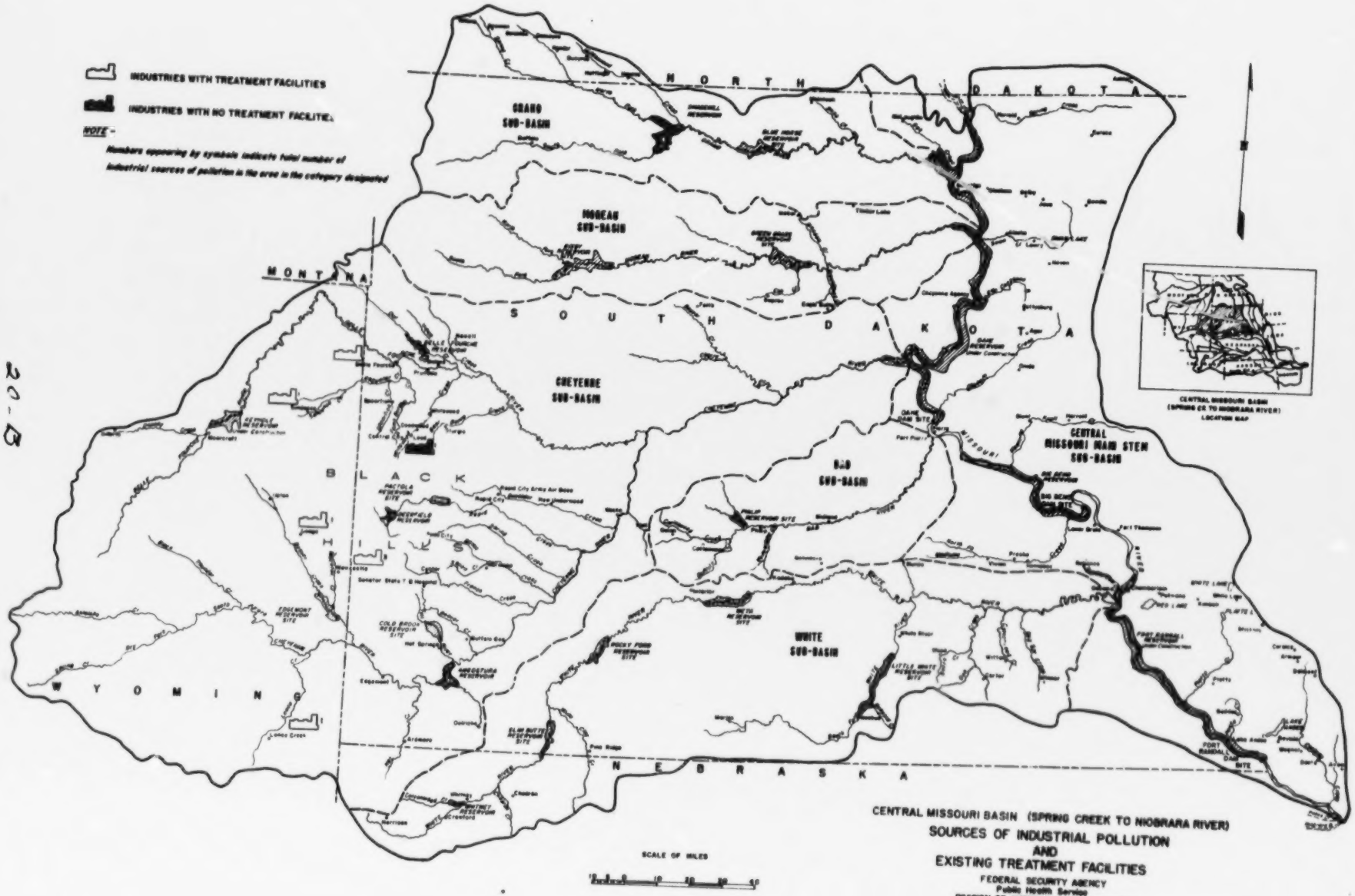


CENTRAL MISSOURI BASIN (SPRING CREEK TO NIOBRARA RIVER)

SOURCES OF MUNICIPAL POLLUTION
AND
EXISTING TREATMENT FACILITIES

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 3

A-22



20-B

CENTRAL MISSOURI BASIN (SPRING CREEK TO NIOBRARA RIVER)
SOURCES OF INDUSTRIAL POLLUTION
AND
EXISTING TREATMENT FACILITIES

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 4

Much of the area lying within this drainage basin is easily eroded and most of the streams carry excessive amounts of silt. Many streams have little or no fishing value due to their high silt content. It is expected that large quantities of the silt will be removed by sedimentation when proposed reservoirs are completed.

BENEFITS RESULTING FROM POLLUTION PREVENTION AND ABATEMENT

The provision for adequate treatment of municipal and industrial wastes will be of particular benefit to fishing, recreational water uses, and irrigation interests. The petroleum industry might realize sufficient benefits from recovery of oil and refining materials to more than cover the costs of providing treatment facilities, not to mention the salutary effect that the removal of these oils and chemicals would have upon the receiving stream.

The Utah and Idaho Sugar Refining Company at Belle Fourche might also effectively benefit through recovery of products now reaching the streams as waste. The Belle Fourche River below the sugar refinery would benefit if the wastes were removed from the stream, however it would also be necessary to increase the flow of water if there is to be a realization of a substantial increase in fishery value.

If adequate treatment were provided municipal wastes at Chadron, Nebraska, and roundhouse and oil refinery wastes excluded, the fishery in the White River below Chadron would be increased substantially.

The development of an adequate sewage collection system for the residential districts of Rapid City where sewage is now being discharged through septic tanks into Rapid Creek, and if sewage from clandestine connections to storm sewers were eliminated the value of Rapid Creek as a recreational area would be greatly enhanced. The present situation constitutes a public health hazard and preventive measures would insure against possible disease transmission.

The reduction of silt by soil conservation methods and sedimentation within reservoirs would tend to reduce operation and maintenance costs at water treatment plants. The Cities of Chamberlain, Fort Thompson, Mobridge and Lower Brule, South Dakota, would benefit from silt reduction.

One of the most important but less tangible aspects of pollution control is the aesthetic value of a clean stream. It is difficult to assess a monetary value on the aesthetic, however this in no way diminishes from its importance. It is axiomatic that when a man's surroundings are pleasant and healthful he tends towards a longer and more productive life. Clean streams contribute much to the improvement of man's environment.

POLLUTION PREVENTION MEASURES IN EFFECT

Forty-three of the 58 sewered municipalities treat wastes before discharge to streams of the Basin. Twenty-four, or about 41 percent, have primary treatment facilities; 19, or about 33 percent, have secondary treatment plants. Fifteen of the sewered communities discharge untreated wastes. Table 7 summarizes municipal waste treatment now in effect.

Primary treatment plants serve about 21,000 people and discharge approximately 16,900 population equivalents; secondary treatment facilities reduce 49,000 population equivalents to about 6,600. Municipalities without treatment facilities add about 33,000 population equivalents to watercourses. Treatment removes about 46 percent of the polluting material of municipal origin.

Progress in pollution abatement is reflected in the data presented in table 8. In the years 1946 and 1948 no municipal treatment plants were completed. In 1947 one municipal treatment plant was completed to handle the wastes of 350 people; in 1949 three treatment plants, designed for a total of 11,500 people, were completed; four plants with facilities for 6,360 people were finished in 1950. No industrial waste treatment plants were constructed in the corresponding years.

The petroleum industry with oil fields in the Lance Creek area, and refineries at Upton, Osage, and Sundance, Wyoming, produce both organic and inorganic wastes. Minor or partial treatment facilities are employed to recover oil. Operation efficiencies of these works remain to be determined. The sugar refinery at Belle Fourche discharges its wastes into lagoons, thence to the stream. The treatment provided is not yet entirely adequate. The organic population equivalent strength of waste discharged by the sugar refinery is estimated at 190,000.

Most of the municipal treatment plants in the Basin are satisfactory in design capacity and in adequacy of operation. This is due to the active pollution control programs of the State agencies. The unsatisfactory plants remain as a challenge to better pollution control. The adequacy of capacity and operation is shown in table 9.

In Nebraska the State Department of Health has general supervision and control over matters relating to public health and sanitation and is authorized by statute to adopt reasonable rules and regulations as will best serve to promote sanitation throughout the State. The sanitation division of the health department administers the limited powers and duties relating to water pollution. The Nebraska State Department of Health cooperates with various State and Federal agencies in connection with water pollution control problems. The State Department of Health requires submission of plans and specifications for sewage systems serving more than 25 persons. The State Fish and Game Agency may take action through county attorneys to secure abatement of pollution harmful to aquatic life. Penalties are provided for failure to

Table 9. Central Missouri Basin - Adequacy of existing treatment facilities - Municipal and industrial

Existing treatment facilities	Number	Adequacy with relation to: Capacity			Operation		
		Satis-factory	Unsatis-factory	Undeter-mined	Satis-factory	Unsatis-factory	Undeter-mined
Municipal*	43	24	19	0	29	14	0
Industrial**	7	0	7	0	0	7	0

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.

**Industries having separate outlets discharging wastes directly to watercourse.

comply with rules and regulations of the Department of Health, however, water pollution enforcement provisions are not comprehensive and are therefore inadequate.

Revised statutes of Nebraska indicate that sanitary districts may be formed and include a provision that such districts may construct, operate, and maintain sewage works. General obligation bonds up to 10 percent of the assessed valuation of taxable property may be issued and revenue bonds may be used to finance projects in the event the 10 percent limit does not cover the costs. Villages and cities may issue mortgage bonds which do not impose any general liability upon the municipality and are secured by the property--the sewage works and revenue derived therefrom.

Cities and villages are authorized to own, construct, equip and operate sewage works within or outside the city or village and allow for condemnation of necessary land, the levying of taxes, and the issuance of bonds in accordance with statutory provisions. Cities and villages may also adopt rules and regulations governing the use of sewers and treatment plants and charges for the use of such system.

Nebraska has a fairly good record in water pollution control. State Department of Health personnel enjoy the confidence of State and city officials and the general public. While present key personnel are experienced, development of an effective water pollution program is limited by a lack of adequate funds and staff.

South Dakota provides for a committee on water pollution control. Technical work is done under the direction of the Director, Division of Sanitary Engineering of the State Department of Health. The pollution control program in the State has been quite effective. A more adequate budget and additional personnel would stimulate progress.

The committee on water pollution classifies public waters of the State; issues permits governing discharge of wastes into Class A waters; and shares with the State Department of Health comprehensive authority for enforcement of pollution abatement laws. The State Department of Health by regulation must approve plans and specifications of any sewage or waste disposal system before its construction may take place. The committee has the authority, after hearings, to issue administrative orders to abate pollution.

Investigations may be ordered by the committee on stream pollution; these investigations are largely directed toward Class A waters. South Dakota has been active in water pollution control and is conducting stream pollution investigations within the State and on border streams in cooperation with other States.

The Wyoming State Board of Health, within the Department of Public Health, has been designated as the water pollution control agency for Wyoming. Review and approval of plans and specifications by the Board of Health and adequate enforcement provisions are provided by statute. There are no exemptions from the jurisdiction of the State Board of Health, except on Indian reservations where the

Indian Service assumes jurisdiction for sewage disposal. The State Board of Health may make rules and regulations, conduct hearings and investigations, and issue orders. The Board has the power to summon witnesses, administer oaths, and hear evidence.

Specific statutory authorization for the formation of sanitation districts outside of incorporated areas was recently provided by the legislature. Adequate provisions for the formation of districts within corporate limits appear to exist. Wyoming has a comprehensive revenue bond law applicable to sewerage works. General obligation bonds may also be used for financing sewerage works, but the total outstanding indebtedness which can be incurred by this method is limited by the State constitution to four percent of the assessed valuation of taxable property. This limitation does not apply to revenue bonds. Sanitation districts are authorized to issue general obligation bonds limited to 10 percent of the assessed valuation. Revenue bonds for sanitary districts are not limited.

The Wyoming State Board of Health is required to investigate complaints of the mayor or health officer of any city or town or the managing board or officer of any public institution or the president of an ice company relating to pollution of water used as a source of water supply. Wyoming has shown increased activity in water pollution control. The State agency recognizes the value of pollution control to protect its natural resources.

In North Dakota authority for pollution control is vested in the Water Conservation Commission, the State Department of Health, local boards of health under the supervision of the State Department of Health, the Industrial Commission, and water conservation districts. Since no State agency has comprehensive authority in the water pollution control field, the State Department of Health has been designated as the State water pollution control agency pursuant to the Federal Water Pollution Control Act.

Several other State agencies have the power to conduct studies, investigation, and research for the abatement of stream pollution. The North Dakota water pollution control agency is empowered to cooperate with other States and the Federal Government, can accept and use funds from the United States for the purpose of preventing water pollution and for public health work.

Municipalities are authorized to accept aid from and cooperate with State and Federal agencies for the establishment, construction, and maintenance of public works for preventing stream pollution or for sewage disposal.

The present staff of the Health Department is small but is of excellent calibre. The State Department of Health has long been active in pollution control and abatement and considerable progress has been made. The Water Conservation Commission, established in 1937, has been devoting its energies primarily to water appropriations and to broad phases of water resources development. North Dakota participates in interstate agencies and has cooperated in

investigations of polluted streams with neighboring States. North Dakota recognizes the fact that a scarcity of good waters exists in many sections of the State, and has done much to focus attention on the need for water pollution control.

POLLUTION PREVENTION MEASURES NEEDED

Present water uses and increased or additional uses possible with improved water quality, together with protection of water rights and property values, largely determine the pollution prevention measures needed. The objective of water pollution control programs is to preserve or reclaim water to best serve these interests. Treatment requirements, like other aspects of water resources development, are generally influenced by economic consideration. In addition, the intangible aspects of moral obligation, aesthetic values, and nuisance conditions exert a powerful and positive influence on the justification of waste treatment facilities.

Water quality objectives have been fairly well developed for such water uses as domestic and industrial water supply, recreation, bathing and supporting fish life. Objectives are less well defined for other uses.

Among the more important objectives of a water pollution control program is protection of water quality in streams used as sources of public water supplies. The quality of raw water is an important factor in the design of water treatment facilities and in their operation and maintenance. The factor of safety which can be incorporated in the best water treatment facility is, however, inversely proportional to the specific concentrations of bacteria and toxic elements in water used as source of supply. Therefore, public health and waterworks officials generally measure water quality in terms of its bacteriological, physical, and chemical characteristics. While definite standards of raw water quality have not been adopted, the Manual of Recommended Water Sanitation Practice, Public Health Service Bulletin No. 296, 1946, recommends the following practices: Underground waters not subject to any possible contamination and meeting in all respects the requirements of the Public Health Service Drinking Water Standards as shown by satisfactory, regular, and frequent sanitary inspections and laboratory tests, requires no treatment. Underground or surface waters which are subject to a low degree of contamination not averaging more than 50 coliforms (M.P.N.) per 100 ml. of sample in any month and meeting the requirements of the Public Health Service Drinking Water Standards in all other respects should receive a minimum of simple chlorination or its equivalent. Waters which require filtration treatment for turbidity and color removal, waters of high or variable chlorine demand, and waters polluted by sewage to such an extent as to be inadmissible in the prior groups, but containing numbers of coliform bacteria averaging not more than 5,000 coliforms (M.P.N.) per 100 ml. of sample in any one month and exceeding this number in not more than 20 percent of the samples examined in any one month, should be provided complete rapid sand filtration treatment or its equivalent, together with continuous postchlorination. Waters which meet the requirements of the previous statement

with respect to the limiting monthly average coliform numbers but showing numbers of coliforms exceeding 5,000 M.P.N. per 100 ml. in more than 20 percent of the samples examined during any one month and not exceeding 20,000 per 100 ml. in more than 5 percent of the samples examined during any month, should be provided auxiliary treatment in addition to filtration and postchlorination. Auxiliary treatment as used here is presedimentation or prechlorination or their equivalents either separately or combined as may be necessary. Long time storage for periods of 30 days or more represents a permanent and reliable safeguard which in many cases would provide something more than an effective substitute for one or both of the two other methods indicated. Waters which do not meet the requirements cited are considered unsuitable for use as sources of water supply unless they can be brought into conformance with the requirements by means of prolonged preliminary storage or some other measure of equal permanence and reliability, as heavy prechlorination and preliminary coagulation and sedimentation.

In addition to the recommended bacterial requirements, waters for public supply should not contain toxic, taste producing or otherwise harmful substances, or organisms not readily and completely removed by the water treatment processes cited, and should be free of excessive amounts of acid, microscopic organisms, and organic matters causing any interference with the normal operation and efficiency of the water treatment processes. Whether or not upstream domestic and industrial waste is treated often determines the acceptability of a water as a source of domestic of industrial supply.

Standards adopted by the Public Health Service for Drinking and Culinary Water Supplied by Common Carriers in Interstate Commerce prescribe limiting maximum concentrations of certain chemical substances inimical to public health, including the following:

Substance	Maximum concentration in parts per million
Lead	0.1
Fluoride	1.5
Arsenic	0.05
Selenium	0.05
Hexavalent chromium	0.05

These standards have received official approval by the American Water Works Association and general acceptance by official health agencies and waterworks authorities and are widely used as one of the guides for administration of water pollution control programs.

Also of importance are those substances which cause problems of taste and odors. Of particular concern are phenolic and related compounds, minute concentrations of which cause repugnant taste and odor in water supplies. Pollution control programs are aimed at practical elimination of these substances in waters serving as a source of domestic supply.

Quality requirements for industrial water supply vary widely, depending upon the type and nature of industry under consideration. Of general concern are organic and biological constituents, toxic substances, and properties of corrosion, encrustation, and slime formation. Waste control measures materially contribute to improvement of these attributes.

It is generally agreed that a minimum of 5.0 parts per million of dissolved oxygen is necessary, in those streams of the Central Missouri Basin affording a suitable fishery habitat, for support of a balanced aquatic life. Because of limited dilution water during critical periods of low flow, secondary treatment, or removal of not less than 75 percent of the Biochemical Oxygen Demand, is required for a few sources of pollution in the Basin. Removal approaching 90 percent is possible with secondary treatment facilities properly designed and well operated.

Water for recreational usage should be free from floating solids, sludge banks, odors, and discoloration. Contamination of bathing waters by sewage, especially that of recent origin, is objectionable. Recommended objectives for the bacteriological quality of bathing waters are as follows:

For bathing or swimming water, monthly arithmetical average 'most probable number' of coliform organisms should not exceed 1,000 per 100 ml. during any month of the recreational season; nor exceed this number in more than 20 percent of the samples examined during any such month; nor exceed 2,400 per 100 ml. on any day. For nonbathing or nonswimming waters, the monthly arithmetical average 'most probable number' or coliform organisms should not exceed 5,000 per 100 ml. in any month of the recreational season, nor should exceed this number in more than 20 percent of the samples examined during any such month. Fecal streptococci are receiving increasing attention as an index of sanitary quality of bathing water. However, sanitary surveys must continue to play the primary role in pollution control programs as related to bathing waters.

Bacteriological quality objectives of irrigation water endorsed by the State Health Departments of the Basin are as follows:

(1) Sewage used for irrigation of forage crops should be given treatment insuring a consistent reduction in coliform bacteria of not less than 90 percent.

(2) Sewage used for irrigation of human food crops should be given treatment insuring a consistent reduction (a) in suspended solids of not less than 75 percent, (b) in 5-day 20° C. B.O.D. of not less than 75 percent, and (c) in coliform bacteria of not less than 98 percent, unless discharged into a stream where the volume of dilution water, available during the low flow periods during which irrigation diversions may occur, is at least 10 times greater than the anticipated maximum daily volume of sewage, in which case a bacterial reduction of 90 percent may be acceptable.

Provided, however, that where the time of passage from plant discharge to irrigation diversion is such as to permit the normal death rate of bacteria as evidenced by the die-away curve to provide equivalent bacterial reduction, the requirement of (1) and (2) above may be appropriately modified.

The protection of water rights must also be considered in determining pollution prevention measures needed. The doctrine of riparian rights, widely applied in states east of the 98th meridian, holds that "all persons owning land abutting on a natural stream have a right to demand that the water shall pass their lands undefiled in quality and undiminished in quantity."[1] The interpretations of the doctrine vary but in general a "reasonable" approach is applied in which stream uses are permitted which do not substantially lessen its quantity or impair its quality. West of the 98th meridian the doctrine of appropriated water rights is usually accepted, although in many areas State water laws incorporate a portion of both doctrines. Where the doctrine of appropriated water rights prevails, consumptive use of water is permitted but no license is thus given to return water to the stream in a defiled condition. The water laws of the State of Wyoming are based on the doctrine of appropriated water rights and those of North Dakota, South Dakota, and Nebraska contain elements of both doctrines.

Waste treatment measures are usually tailored to the needs of a community following the engineering evaluation of local sanitary problems. Municipal treatment plants are usually of two general types, one of which removes settleable material from the water under quiescent flow conditions and the other removes polluting material by biological means. Within these categories numerous combinations or adaptions thereof can be used to meet variant conditions of waste from a community and requirements of the receiving stream. Industrial treatment processes vary widely, often within the same general type of industry. Changes in processes, by-products recovery, salvage, improved housekeeping, and comparable practices are often very effective measures of controlling industrial pollution. Control of industrial waste may present an entirely different problem than that incurred in municipal wastes, since the wastes may contain toxic or otherwise objectionable substances not amenable to either sedimentation or biological treatment. However, the objective of the control program remains the same--protection of waters by reduction of objectionable substances to within tolerance levels compatible with water uses. The water pollution control programs in the Central Missouri Basin are based on these premises.

While sewage and waste treatment processes cannot be controlled precisely, they can be regulated between rather well established limits. The effective removal of solids from domestic wastes by sedimentation is termed primary treatment and is generally considered to reduce B.O.D.*

[1]Merriman and Wiggins, American Civil Engineers Handbook, page 1750-Legal and Economic Features of Water Rights, 5th Edition.

*Biochemical Oxygen Demand is the quantity of oxygen utilized by microorganisms under aerobic conditions while feeding on and stabilizating organic materials. Tests are based on the standard methods of water and sewage analysis.

from 25 to 40 percent. The removal of Biochemical Oxygen Demand by biological methods is termed secondary treatment. A plant incorporating effective primary and secondary treatment is generally considered capable of removing from 75 to 85 percent of the organic polluting material. Greater reduction, sometimes referred to as tertiary treatment, can be obtained by repetitive passages of wastes through the treatment processes or by increasing the number of combinations of treatment processes. Sewage and waste treatment methods thus defined apply only to organic materials that can be decomposed by biological action or those that may be removed by sedimentation. Inorganic waste such as most acids, alkalies and metallic ions must be controled by recovery, neutralization, storage, evaporation or other specialized processes. In general, the pollution control agencies recognize the need for the following concepts:

(1) Toxic substances including metallic ions, phenol compounds, oils, and acids must be excluded from streams. Such substances are inimical to aquatic life and if present in sufficient concentrations are hazardous to human life and of livestock.

(2) Removal of settleable and floating solids to prevent sludge banks, floating materials, and nuisance conditions should be required as the minimum acceptable treatment.

(3) The degree required beyond effective primary treatment is influenced by downstream water uses and by the amount of dilution water available during periods of low flow. Biological removal of dissolved organic materials and bacteria must be provided where necessary to: (a) maintain dissolved oxygen at levels necessary for balanced aquatic life; (b) maintain desirable water quality for domestic, industrial, or recreational uses; and (c) prevent nuisance or other health hazards.

(4) For industrial wastes similar in nature to municipal wastes, treatment should be based on the same premises as that recommended for municipalities. For industrial wastes not similar to municipal wastes, treatment should be provided as necessary to prevent substantial deterioration of water quality in the receiving stream.

The future water pollution control program in the Central Missouri Basin should include as its pertinent features:

(1) Enactment of comprehensive State pollution control legislation where needed.

(2) Construction of treatment plants where none now exist, and improvement of existing plants where they are presently inadequate to meet needs.

(3) Dissemination of information concerning the effects of pollution on public health, fishing, irrigation, livestock

watering, wild waterfowl production, industrial water supply, recreation and other water uses.

(4) Improved operation and maintenance of existing sewage treatment works.

(5) Periodic surveillance of stream conditions to supplement sewage treatment plant inspections so that needs for improved treatment can be seen well in advance of actual necessity, thus enabling planning and construction to be carried forward with a minimum of delay.

The cost of adequate sewage treatment facilities, including original construction cost, operation and maintenance, has been estimated to be between $9 and $15 per year per family, depending upon the size of the community and degree of treatment required. Costs per family are usually lowered as the size of the community increases. The cost of constructing adequate treatment facilities, including the 17 new municipal plants, 11 enlargements or additions to existing plants, the replacement of 6 municipal plants, the one new industrial waste treatment plant, and enlargements to 4 existing industrial plants in the Central Missouri Basin, is estimated at $1,600,000. The estimate does not include the cost of new sewers to connect treatment works with existing sewer systems, nor does it reflect the cost of operation and maintenance.

Surveys of most of the sources of pollution in the Central Missouri Basin have been made by the State water pollution control agencies, and reports containing findings of the investigations, together with recommendations for correcting or improving conditions, have been provided municipal and industrial officials and other interested parties. The State water pollution control agencies have further cooperated with representatives of numerous industries and municipalities through conferences regarding specific problems of pollution, and have worked closely with engineers officially employed by the municipalities and industries to study pollution problems. These activities were inaugurated several years ago as a part of the continuing program. Municipal and consultant engineering studies, where made, generally substantiate treatment needs as indicated in this report.

The value of supplemental flows from proposed reservoirs as an aid to controlling stream pollution has been recognized by the State pollution control agencies. It is therefore of considerable importance to the residents of the Basin that reservoir operating programs provide water releases to implement sewage and industrial waste treatment wherever feasible.

A resumé of the conditions and needs at the various municipalities and industries where improvements have been recommended are discussed briefly in the following paragraphs:

Eureka, South Dakota

The sewer system of Eureka serves approximately 1,200 people. Sewage is discharged without treatment into Spring Creek, a tributary of the Missouri River. During periods of low flow in the creek, local nuisance conditions develop, therefore the South Dakota State Department of Health recommends that sewage treatment facilities incorporating secondary treatment be provided.

Bowman, North Dakota

The municipality has sewage treatment facilities capable of removing a portion of the settleable material prior to the discharge of sewage into Spring Creek, a tributary of the North Fork of the Grand River. The sewage treatment plant is not considered large enough to produce the desired quality of effluent, therefore the North Dakota State Department of Health recommends that the present works be enlarged sufficiently to provide an adequate degree of treatment.

Hettinger, North Dakota

Sewage from approximately 1,600 residents of Hettinger is collected and provided minor treatment in a septic tank prior to its discharge into Hidden Wood Creek. The septic tank is obsolete and grossly overloaded with the result that during periods of low flow in the creek serious pollutional problems develop in the immediate neighborhood of the treatment plant. The North Dakota State Department of Health recommends that a new modern sewage treatment plant incorporating secondary treatment be constructed.

Mobridge, South Dakota

The City of Mobridge discharges the domestic sewage and industrial wastes into the Missouri River without treatment. The construction of Oahe Dam will produce conditions in the Missouri River at Mobridge similar to those found in a lake or other quiescent bodies of water. In order to prevent local nuisance conditions resulting from floating or settleable sewage matter, the South Dakota State Department of Health recommends that sewage treatment incorporating primary treatment be provided.

Bowdle, South Dakota

Municipal sewage is treated in a plant designed to remove the settleable material prior to its discharge into Swan Creek. The plant is obsolete and is not providing the degree of treatment considered necessary to prevent local nuisance condition. The South Dakota State Department of Health recommends that the present treatment works be enlarged.

Cheyenne Agency, South Dakota

The Cheyenne Indian Reservation Headquarters, together with the community, has been discharging untreated sewage directly into the Missouri River. Upon completion of Oahe Dam it will be necessary to move the entire community because of inundation by waters of the reservoir. Proper sewage treating facilities will be needed at the new location.

Upton, Wyoming

The plant at Upton is of insufficient size to properly treat the municipal sewage. The Wyoming Department of Public Health recommends that the present facilities be enlarged.

Newcastle, Wyoming

A new sewage treatment plant, including secondary treatment as recommended by the State Department of Public Health, is now under consideration at Newcastle. The Carter Oil Refinery, Graco Oil Refinery, and the Wyoming Gas and Oil Company Refinery at Newcastle are in need of better oil recovery facilities and treatment units to remove wastes being discharged from the oil refineries.

Edgemont, South Dakota

Sewage from this municipality is discharged without treatment into the Cheyenne River. The use of Angostura Reservoir for recreation, together with plans for irrigation of land immediately below Edgemont, indicates that sewage treatment will be needed. The South Dakota State Department of Health recommends that sewage treatment facilities, incorporating secondary treatment, be constructed at Edgemont.

Rapid City, South Dakota

The rapidly increasing population of Rapid City has made it necessary to expand the present sewage treatment facility in order to adequately control pollution in the waters of Rapid Creek. This improvement is now under construction.

Gillette, Wyoming

The sewage treatment plant is grossly overloaded as well as obsolete. The Wyoming Department of Public Health recommends that the entire unit be replaced by modern sewage treatment works. The improvement is necessary to prevent local nuisance conditions during those portions of the year when flow in the creek is low and the sewage undergoes putrefaction within a short distance of the sewer outfall.

Moorcroft, Wyoming

Sewage from the municipality is given primary treatment prior to its discharge into Belle Fourche River. During periods of low flow in the river local nuisance conditions have developed due to the

excessive deposition of sewage solids near the outfall of the plant. The Wyoming Department of Public Health recommends that the treatment works be enlarged.

Belle Fourche, South Dakota

Sewage from about 2,500 people and from small industries within the city is discharged untreated into the Belle Fourche River. In addition to the municipal sewage, the Utah and Idaho Sugar Refinery located a few miles downstream from Belle Fourche discharges a portion of its industrial waste into the river. The South Dakota State Department of Health has recommended that Belle Fourche construct a sewage treatment facility incorporating secondary treatment. Under present conditions much of the municipal sewage finds its way into Belle Fourche Reservoir through the diversion of the river immediately below the city. Wastes from the sugar refinery enter the river below the diversion dam. Improved treatment facilities should be provided for the refinery wastes.

Newell, South Dakota

The municipality of Newell, lying within the heart of the Belle Fourche irrigation project, discharges sewage, after minor treatment, into an irrigation drain. In order to prevent local nuisance conditions and health hazards, the South Dakota State Department of Health recommends replacement of the present treatment facility with a modern plant providing effective primary treatment.

Lead, South Dakota

Sewage from the city is discharged untreated into White Wood Creek. The creek flows through Deadwood, located but a short distance downstream. A sewage polluted stream under these conditions presents obvious public health hazards. The South Dakota State Department of Health recommends that primary treatment be provided.

Deadwood, South Dakota

Untreated sewage from Deadwood is discharged into White Wood Creek, and the stream through and below the city is heavily fouled with sewage. A sewage polluted stream so near the city obviously presents a public health hazard. The South Dakota State Department of Health recommends that primary treatment be provided.

Spearfish, South Dakota

The population of Spearfish contributing to the sewage treatment plant has been increasing rapidly. Recent investigations by the South Dakota State Department of Health indicate that the secondary treatment plant is rapidly becoming overloaded, and therefore recommends that the present plant be enlarged.

Faith, South Dakota

The sewage treatment facilities at Faith incorporate secondary treatment but the plant has been overloaded to such an extent that it is no longer capable of producing an effluent which will not become septic and malodorous during periods of little or no flow in the receiving streams. The South Dakota State Department of Health has recommended that the present plant be enlarged sufficiently to insure adequate treatment.

Onida, South Dakota

Treatment facilities have been provided capable of removing a portion of the settleable material from the sewage prior to its discharge into the small receiving creek. The plant, however, has become obsolete and during periods of low flow or dry weather the sewage causes a local nuisance condition. The South Dakota State Department of Health recommends that the present plant be enlarged.

Pierre, South Dakota

At the present time Pierre discharges sewage and industrial waste into the Missouri River without treatment. The South Dakota State Department of Health recommends treatment sufficient to remove settleable and floating sewage matter. At the completion of the reservoir construction program on the main stem of the Missouri River sewage treatment will be necessary to prevent local nuisance conditions in the quiescent waters of Big Bend Reservoir immediately below the city.

Fort Pierre, South Dakota

At present sewage and wastes are being discharged into the Missouri River at Fort Pierre. However, a situation similar to that at Pierre is anticipated, therefore sewage treatment incorporating facilities for removing settleable and floating sewage matter is recommended for installation by the South Dakota State Department of Health.

Philip, South Dakota

Municipal sewage from approximately 650 people is provided a minor degree of treatment prior to its discharge into the Bad River. Unsatisfactory stream conditions due to insufficient treatment of the sewage has led the South Dakota State Department of Health to recommend that the plant be enlarged.

Kadoka, South Dakota

The Kadoka treatment plant is overloaded and obsolete. The South Dakota State Department of Health has recommended that it be replaced by a modern plant. Under present conditions the poorly treated sewage decomposes a short distance below the treatment plant causing local odor and nuisance conditions.

Presho, South Dakota

Existing treatment facilities at Presho remove a portion of the settleable material from municipal sewage prior to its discharge into Medicine Creek. Removal, however, is insufficient to prevent odors and nuisances from developing in the waterway during periods of low flow. The South Dakota State Department of Health recommends that the entire unit be replaced by a new primary treatment plant.

Fort Thompson, South Dakota

Fort Thompson is located within the area to be inundated by Fort Randall Reservoir and must be moved from its present site. It will undoubtedly be necessary to provide proper sewage collection and treatment facilities for the relocated municipality.

Chamberlain, South Dakota

Municipal sewage from Chamberlain is discharged without treatment into the Missouri River. Upon completion of Fort Randall Dam the sewage will be discharged into the quiescent waters of Fort Randall Reservoir. Sewage solids settling in the quiet waters of the reservoir will undergo decomposition, causing local nuisance condition. Floating matter will also present nuisance problems. Sewage treatment is necessary to permit full recreational use of the reservoir in the Chamberlain area. The South Dakota State Department of Health recommends the construction of a sewage treatment works incorporating primary treatment. Planning for sewage treatment has begun.

Crawford, Nebraska

The present sewage plant at Crawford provides secondary treatment, however the growth of the municipality and the obsolescence of the plant have resulted in unsatisfactory effluent. The Nebraska State Department of Health recommends that the present works be enlarged sufficiently to insure effective secondary treatment prior to discharge of the effluent into the White River. Irrigation, stock watering and fishing interests below the municipality would benefit by the recommended improvement.

Chadron, Nebraska

Sewage from Chadron is given primary treatment prior to its discharge into Chadron Creek. Existing treatment is insufficient during periods of low flow in Chadron Creek. Nuisance conditions arising from decomposition of sewage in the creek has led the Nebraska State Department of Health to recommend the replacement of the present treatment works with a plant incorporating secondary treatment.

Kimball, South Dakota

The municipality of Kimball provides primary treatment prior to discharging its sewage into a small stream, tributary to Platte Creek. The present plant does not provide sufficient treatment during periods

of low flow in the receiving stream and decomposing sewage results in a local nuisance condition. The South Dakota State Department of Health has recommended that the present sewage plant be replaced with facilities providing secondary treatment.

Platte, South Dakota

Sewage from about 1,000 residents of Platte reaches a treatment plant, the efficiency of which is low because of overloading and obsolescence. Conditions in the receiving stream are very poor during times of low flow, causing local nuisances and interfering with livestock water uses. The South Dakota State Department of Health recommended that the plant be replaced. A new plant is now under construction.

Wagner, South Dakota

Sewage from the city is provided primary treatment prior to its discharge into Choteau Creek, however, the plant is greatly overloaded and fails to provide treatment necessary to prevent nuisances in the receiving stream. The South Dakota State Department of Health recommends that the present treatment works be enlarged.

Avon, South Dakota

At the present time sewage from Avon is discharged without treatment into Choteau Creek. In order to prevent nuisances and to protect livestock watering, the South Dakota State Department of Health recommends the installation of a treatment works incorporating secondary treatment.

Lance Creek Oil Fields

A considerable quantity of crude oil is produced from wells located in the Lance Creek Field of east central Wyoming. The crude is of high quality however, as occurs in most fields, there is some leakage of oil into the waterways draining the field. The quantity of oil escaping to the waterways is presently unknown. Better control is recommended.

Menewal and Bradley Oil Refinery

This refinery, located at Osage, Wyoming, contributes refinery wastes to the small creek in the vicinity of Osage. While little is known concerning the operation of this plant, improved control of pollution has been recommended by the State agency having jurisdiction.

Cook County Oil Refinery at Sundance, Wyoming

This refinery has equipment to remove part of the oil and other materials discharged from refinery operation. It is, however, inadequate to provide the degree of treatment necessary, therefore the Wyoming State Department of Public Health has recommended that the facilities be enlarged and improved sufficiently to provide adequate control of the wastes.

The needs cited are summarized in table 10, and on maps 5 and 6. The progress being made by the municipalities and industries in achieving the recommended controls is shown in table 11.

Table 10. Central Missouri Basin - Needs for municipal and industrial waste treatment plants

Needs	Municipal		Industrial*
	Number	Population served by facilities	Number
New plant	17	38,860	3**
Enlargement or additions to existing plant	11	33,840	4
Replace existing plant	6	5,150	0
No project required	24	25,500	1

*Industries having separate outlets discharging wastes directly to watercourse.

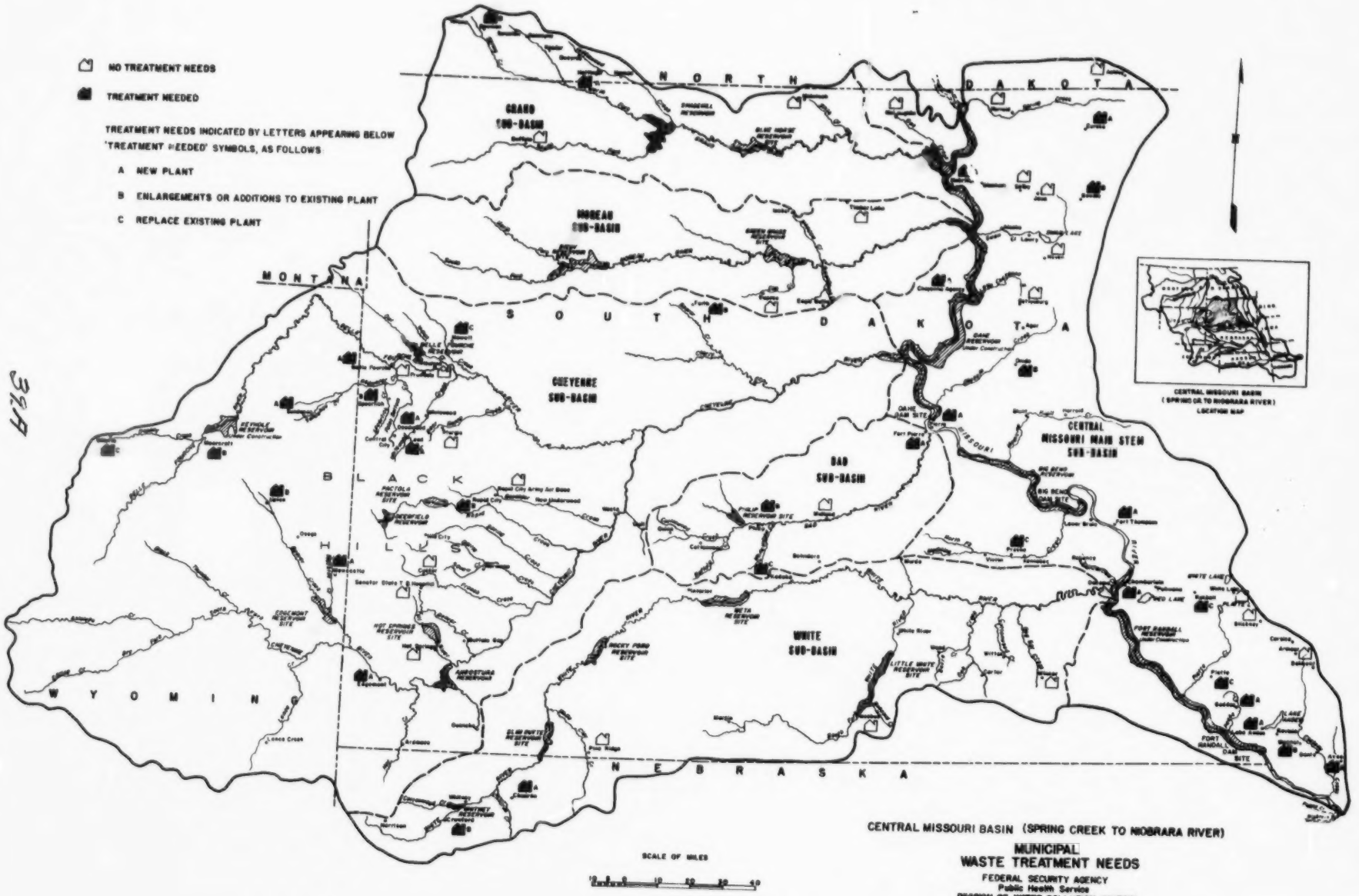
**Two plants need improved control measures.

Table 11. Central Missouri Basin - Current status of municipal and industrial action on pollution abatement needs

Status of project	Number of municipalities*	Number of industries**
Inactive	30	6
Active planning	1	0
Final plans approved	1	0
Under construction	2	1

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

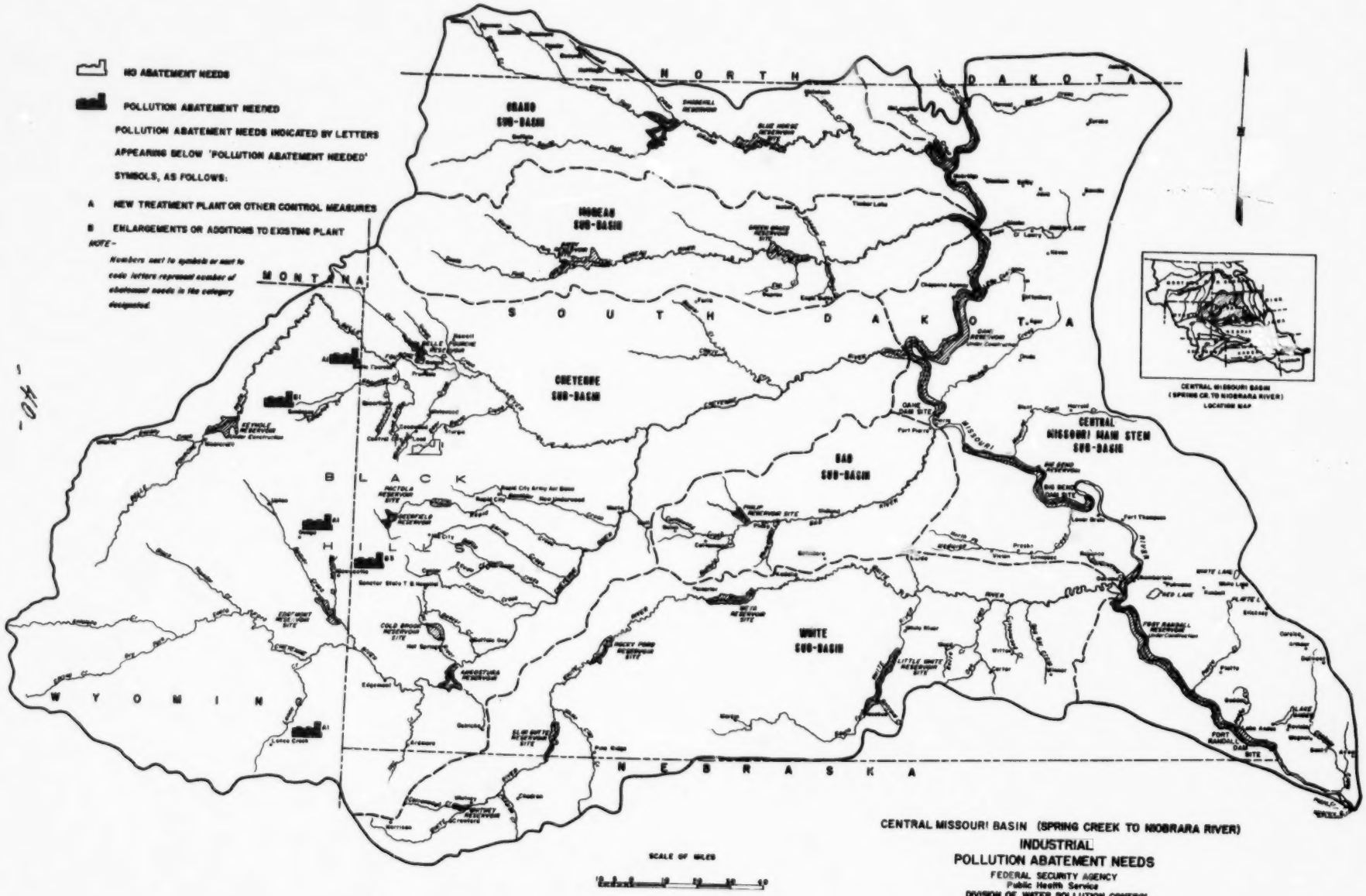
**Industries having separate outlets discharging wastes directly to watercourse.



CENTRAL MISSOURI BASIN (SPRING CREEK TO NIOBRARA RIVER)

MUNICIPAL WASTE TREATMENT NEEDS

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 5


NO ABATEMENT NEEDS
POLLUTION ABATEMENT NEEDED
POLLUTION ABATEMENT NEEDS INDICATED BY LETTERS APPEARING BELOW 'POLLUTION ABATEMENT NEEDED' SYMBOLS, AS FOLLOWS:
A NEW TREATMENT PLANT OR OTHER CONTROL MEASURES
B ENLARGEMENTS OR ADDITIONS TO EXISTING PLANT
NOTE -
Numbers next to symbols or next to code letters represent number of abatement needs in the category designated.
NORTH DAKOTA
SOUTH DAKOTA
MONTANA
WYOMING
NEBRASKA
GRAND SUB-BASIN
MOREAU SUB-BASIN
CHEYENNE SUB-BASIN
BAD SUB-BASIN
WHITE SUB-BASIN
CENTRAL MISSOURI MAIN STEM SUB-BASIN
BLACK HILLS
CENTRAL MISSOURI BASIN (SPRING CR. TO NIOBRARA RIVER) LOCATION MAP
SCALE OF MILES
0 5 10 20 30 40

CENTRAL MISSOURI BASIN (SPRING CREEK TO NIOBRARA RIVER)

INDUSTRIAL

POLLUTION ABATEMENT NEEDS

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 6

Table 12. Central Missouri Basin - Probable frequency of low mean monthly discharges

Years of record	Stream and Location	Drainage area square miles	Minimum monthly mean flows in cubic feet per second that may be expected once in: (1) 3 years	5 years	10 years	Minimum
	SUMMER PERIOD (JUNE-SEPT)					
	Missouri River					
14	Mobridge, S. D.	208,700	11,607	8,319	5,815	4,598
13	Pierre, S. D.	243,500	10,625	8,378	5,934	4,752
	Grand River					
5	Shadehill, S. D.	3,120	10	9	8	7.54
13	Wakpala, S. D.	5,510	3	1	0	0
	Moreau River					
5	Faith, S. D.	2,660	6	4	2	2.09
5	Eagle Butte, S. D.	4,320	5	1	0.1	0.10
13	Promise, S. D.	5,223	1	0.02	0	0
	Cheyenne River					
5	Hot Springs, S. D.	8,710	19	18	18	18.0
12	Wasta, S. D.	12,800	46	37	30	29.9
13	Eagle Butte, S. D.	24,500	216	113	79	46.9
	Fall River					
8	Hot Springs, S. D.	137	26	25	25	24.8
	Beaver Creek					
10	Buffalo Gap, S. D.	130	1	1	1	0.51
	Rapid Creek					
6	Rapid City, S. D.	410	42	40	38	38.0
	Belle Fourche River					
10	Moorcroft, Wyoming	1,730	0.1	0	0	0
10	Hulett, Wyoming	2,800	4	1	1	0.54
9	Belle Fourche, S. D.	4,310	27	20	12	9.5
12	Elm Springs, S. D.	7,210	131	53	23	0.217
	Bad River					
12	Fort Pierre, S. D.	3,107	0	0	0	0
	North Fork Bad River					
6	Philip, S. D.	164	0	0	0	0
	White River					
8	Crawford, Nebr.	295	9	9	9	8.34
8	Chadron, Nebr.	750	2	2	2	1.65
5	Oglala, S. D.	2,200	23	17	11	11.4
6	Kadoka, S. D.	5,000	41	26	18	17.2
13	Oacoma, S. D.	10,200	57	48	20	0.75
	South Fork White River					
5	Rosebud, S. D.	1,020	52	51	50	49.9
	WINTER PERIOD (DEC.-FEB.)					
	Missouri River					
14	Mobridge, S. D.	208,700	5,684	5,271	4,953	3,381
13	Pierre, S. D.	243,500	5,693	5,528	4,832	3,261
	Grand River					
4	Shadehill, S. D.	3,120	0.6	0.2	0	0
12	Wakpala, S. D.	5,510	0	0	0	0
	Moreau River					
4	Faith, S. D.	2,660	0.3	0.1	0	0
4	Eagle Butte, S. D.	4,320	0	0	0	0
10	Promise, S. D.	5,223	0	0	0	0
	Cheyenne River					
4	Hot Springs, S. D.	8,710	21	20	19	19.3
10	Wasta, S. D.	12,800	58	44	39	36.3
13	Eagle Butte, S. D.	24,500	44	31	23	8.7
	Fall River					
8	Hot Springs, S. D.	137	26	24	15	11.8
	Beaver Creek					
10	Buffalo Gap, S. D.	130	8	8	7	6.9
	Rapid Creek					
5	Rapid City, S. D.	410	34	33	33	32.6
	Belle Fourche River					
5	Moorcroft, Wyoming	1,730	0	0	0	0
9	Hulett, Wyoming	2,800	3	1	1	0.4
9	Belle Fourche, S. D.	4,310	127	103	94	92.1
10	Elm Springs, S. D.	7,210	15	7	3	2.0
	Bad River					
11	Fort Pierre, S. D.	3,107	0	0	0	0
	North Fork Bad River					
5	Philip, S. D.	164	0	0	0	0
	White River					
7	Crawford, Nebraska	295	18	18	17	16.8
8	Chadron, Nebraska	750	4	3	1	1.0
4	Oglala, S. D.	2,200	12	9	7	7.2
5	Kadoka, S. D.	5,000	23	15	8	8.1
13	Oacoma, S. D.	10,200	43	19	14	12.8
	South Fork White River					
4	Rosebud, S. D.	1,020	63	57	53	54.4

(1) Based on data from U. S. Geological Survey, Department of the Interior.

APPENDIX A

Table 13. Central Missouri Basin - Reservoirs and dams

Reservoir[1]	River	State	Storage acre-feet	Acres to be irrigated	Status
Shadehill	Grand	S.D.	134,000	13,000) 28,500)	E
Blue Horse	Grand	S.D.	50,000	16,500	P
Bixby	Moreau	S.D.	90,000	27,150	P
Pactola	Rapid Creek		-	-	Study
Belle Fourche	Belle Fourche	S.D.	203,000	73,000	E
Keyhole	Belle Fourche	S.D.	276,000	-	CN
Deerfield	Rapid Creek	S.D.	160,000	-	E
Angostura	Cheyenne	S.D.	160,000	41,300	E
Edgemont	Cheyenne	S.D.	45,000	8,000	P
Cold Brook	Fall River	S.D.	6,260	0	CN
Cottonwood Springs	Cottonwood Springs Creek	S.D.	6,160	0	P
Philip	Bad	S.D.	15,000	4,300	P
Whitney	White	Nebr.	15,000	10,000	E
Rocky Ford	White	S.D.	70,000	42,000	P
Slim Butte	White	S.D.		-	P*
Weta	White	S.D.		-	P*
Little White				-	P*
Oahe	Missouri	S.D.	19,600,000	150,000**	CN
Big Bend	Missouri	S.D.	250,000	-	
Ft. Randall	Missouri	S.D.	5,100,000	-	CN

[1]Data from reports of the Corps of Engineers, Department of the Army, ...nate Document No. 191, and the Bureau of Reclamation's Plan for ...ssouri Basin Development.

*Now under study.
**Area located in James River Valley.

Status - E - Existing
CN - Construction Now
P - Proposed

APPENDIX B

REVIEW OF NEBRASKA WATER POLLUTION LAWS

Summary

Nebraska has specific need for the enactment of comprehensive water pollution control legislation based on the fundamental principles upon which the suggested State Water Pollution Control Act has been developed. The existing State water pollution laws are inadequate for present day needs. The powers of the State Health Department should not be limited to the public health aspects of water pollution. They should apply to all pollution detrimental to water use and there should be no division of authority. Enabling legislation for cities appears to be adequate. Sanitary districts can be formed. The State's water pollution control program has accomplished considerable improvement but much remains to be done. Serious handicaps to this program have been lack of personnel and inadequate laws. Both of these deficiencies should be corrected.

Administrative Authority

Nebraska does not have a comprehensive water pollution law and there is no statutory requirement for the development of a broad water pollution control program or the administrative enforcement thereof. Comprehensive water pollution control legislation should be enacted as soon as possible. The only statutory authority for water pollution control in Nebraska is given in Section 81-602, Revised Statutes of Nebraska which states, "The Department of Health shall have general supervision and control over matters relating to public health and sanitation . . . . ."

The State Health Department is authorized by this statute to adopt reasonable rules and regulations as will best serve to promote sanitation throughout the State.

Definitions

Definitions of the terms "pollution", "wastes", "sewerage system", "treatment works", "disposal system", etc., should be included in comprehensive water pollution legislation adopted for Nebraska.

Section 37-516, Revised Statutes of 1943, defines "refuse" as all substances harmful to aquatic life and forbids its discharge into the waters of the State. However, this statute exempts corporations, villages, and cities of the second class discharging sewage or refuse prior to August 21, 1931, and is not of great value to a general pollution control program.

Powers and Duties

Comprehensive Programs: Cooperation - The powers and duties of the State Health Department, as far as water pollution is concerned, are administered through the Sanitation Division of the Health Department whose functions are principally advisory and educational. As now administered these powers and duties relating to water pollution control appear to be limited.

The Nebraska State Health Department, while not specifically authorized to do so by statute, does cooperate with various State and Federal agencies in connection with water pollution control problems. Such cooperation should be authorized by statute.

Investigations - The State Health Department conducts water pollution investigations under the very general authority granted to it by the statutes. More specific authority would be desirable.

Stream Standards and Classification - There is no specific authority for classification of waters according to use or the adoption of stream standards. Section 81-602 might possibly be construed to grant this authority, but specific legislation is needed.

Rules and Regulations - General health department authority for the adoption of rules and regulations is contained in Section 81-602. Specific statutory authority in the field of water pollution should be given to a water pollution control authority.

Permits - No permit system is now in operation. Such a system is considered administratively desirable and should be included in future water pollution control legislation.

Orders for Pollution Abatement - There is no specific authority provided by statute. Presumably, however, the State Health Department could act if there was a serious public health hazard. Specific statutory authority is needed. This authority should cover all forms of water pollution and should not be limited to public health problems alone.

Plans and Specifications - Submission is required by the State Health Department rules and regulations for systems serving more than 25 persons. No mention is made of plans for industrial waste treatment plants, however.

Federal Water Pollution Control Act - There is no specific statutory authority for cooperation with the Federal Government in connection with the Federal Water Pollution Control Act.

Division of Authority - There is some division of authority and responsibility between the State Fish and Game Agency and the State Health Department. The State Fish and Game Agency may take action through county attorneys to secure abatement of pollution harmful to aquatic life. In the enactment of comprehensive water pollution control legislation, a single State agency should be designated and its powers should be broad enough to include this and all other types of water pollution problems.

Enforcement

Penalties are provided for failure to comply with the Health Department's rules and regulations. Fines vary from $15 to $100 for each offense. As far as water pollution is concerned, enforcement provisions appear to be deficient. This phase of a comprehensive pollution law is important and should be strengthened in future legislation.

Sanitary Districts

Section 31-701, et seq, Revised Statutes, Supplement, 1947, indicate that sanitary districts may be formed and that such districts may provide for the construction and maintenance of necessary sewage works. (Certain areas may not be included in such districts). General obligation bonds up to 10 percent of the assessed valuation of taxable property may be issued. Revenue bonds may also be used to finance such projects and in such cases the 10 percent limit does not apply.

Statutes Governing Financing of Pollution Abatement Works

All villages and cities may issue "mortgage bonds" (section 18-502). These bonds do not impose any general liability upon the municipality and are secured by the property; e.g., the sewage works, and revenues derived therefrom. This is the equivalent to sewer service charge financing and is undoubtedly of considerable value to the municipalities in financing sewage treatment works.

All cities and villages are authorized by Section 18-501, et seq, to own, construct, equip and operate sewage works within or outside the city or village. They may condemn the lands needed, levy taxes, issue bonds, or as previously noted, mortgage bonds in accordance with statutory provisions. Cities and villages may also adopt rules and regulations governing the use of sewers and treatment plants and charges for the use of same. If the charge is not paid, the city or village may recover by action of assumpsit or the charge may be certified to the tax assessor and assessed against the property served.

Municipal finance laws do not appear to have retarded the progress of water pollution control in Nebraska.

Water Pollution Control Program

Nebraska has a fairly good record in water pollution control and the State Health Department enjoys the confidence of State and city officials and the public at large. Undoubtedly the State's program has been seriously handicapped by inadequate statutory backing. There is a definite need for adequate legislation. The educational aspects of the program should be improved. The holding of hearings may be desirable to intimately acquaint the public with pollution control program and to gage public opinion regarding pollution abatement procedures. Legal action against extremely recalcitrant cases may be indicated.

Another serious handicap has been lack of a sufficient number of competent engineers on the State Health Department's staff. Present key personnel are experienced and competent but cannot handle the work throughout the State unaided. Funds should be provided for increasing the engineering staff assigned to pollution control work.

Of the total Nebraska population served by sewer systems, about 46 percent are tributary to sewage treatment plants. Of the cities having sewer systems, about 56 percent provide treatment. Similar national statistics indicate that about 63 percent of the sewered population are served by treatment facilities and that about 61 percent of the sewered communities provide treatment.

REVIEW OF NORTH DAKOTA WATER POLLUTION LAWS

Summary

North Dakota has no comprehensive water pollution control legislation. The authority that exists is placed in the Water Conservation Commission, the State Department of Health, local boards of health under the supervision of the State Department, the Industrial Commission, and water conservation districts. Since no State agency has comprehensive authority in the water pollution control field, the State Department of Health has been designated as the State water pollution agency pursuant to the Federal Water Pollution Control Act.

The State Health Department has been active in the field of water pollution control and considerable progress has been made. The principal weaknesses have been the lack of adequate statutory support and insufficient personnel. Both of these deficiencies should be corrected.

Administrative Organization

Water Conservation Commission. The Commission, a public corporation, was established in 1937 (Laws 1937, c. 255) for water conservation, flood control, and the abatement of stream pollution. Its membership consists of the Governor, who is the chairman, and of four other members appointed by him. The Commission may appoint assistants and fix their compensation. R.C. 1943, 61-0201 to 61-0213.

State Department of Health. The State Department of Health consists of the Health Council, the State Health Officer, the directors of divisions, and other employees of the Department.

The Health Council is composed of nine members appointed by the Governor. The members are representatives of various interested professions and groups and of the public.

The executive officer of the Department is the State Health Officer who is appointed by the Governor. He must be a physician who has special training or experience in public health administration.

The Department has certain named divisions, including a Division of Sanitary Engineering. Other divisions may be added by the Council. The State Health Officer appoints and prescribes the duties of the division directors. R.C. 1947 Supp., c. 2301.

Powers and Duties

Development of Comprehensive Programs. There is no express statutory authority to develop a comprehensive program, to set standards of water purity, or to classify waters.

Issuance of Permits and Review of Plans and Specifications. No sewage disposal plant may be constructed without the prior approval of the Commission and of the Department of Health. R.C. 1943, 61-0221.

Enforcement. There is no express authority to hold hearings or to issue orders. Every person who wilfully violates or refuses or omits to comply with any lawful order, direction, prohibition, or regulation of a board of health or of a health officer is guilty of a misdemeanor and shall be punished by imprisonment for not more than 30 days or by a fine of not more than $1,000, or both. R.C., 1943, 23-0512.

Every person who throws or deposits any gas tar or refuse of any gas house or factory into any public water or into any sewer or stream emptying into public water is guilty of a misdemeanor, R.C., 1943, 61-0112.

The following acts are also misdemeanors pubishable by a fine of not more than $100:

(1) The placing of dead animals, refuse, privies or privy vaults upon the banks or in the water of any lake or stream within the jurisdiction of the State;

(2) The placing of any structure or corral within which horses, cattle, swine, or sheep are kept within 60 feet of the top of the bank of a stream or lake;

(3) The placing of a slaughterhouse or grave within 80 feet of a lake or stream. R.C. 1943, 61-0113 and 61-0114.

Any person who places sawdust or other refuse in water in which fish abound, or in which the State or Federal Government has placed or may place fish or fish eggs is guilty of a misdemeanor and shall be punished by a fine of not more than $100 or by imprisonment of not more than 30 days, or both. R.C., 1943, 20-0124 and 20-0612.

To deposit liquid waste from a rendering plant upon the surface of the ground, or to dispose of it in a manner which makes any water supply unfit for human or livestock use is a misdemeanor punishable by a fine of not more than $100 or by imprisonment of not more than 90 days, or both. R.C., 1943, 36-0705 and 36-0714.

Conduct of Studies, Investigations, and Research. The Water Conservation Commission has power to investigate and plan all works, dams, and projects "to provide sufficient water flow for the abatement of stream pollution." R.C. 1947 Supp., 61-0214f.

The Commission may investigate, plan, and cooperate with other States, the Federal Government, and the Dominion of Canada for the purpose of preventing water pollution. R.C. 1943, 61-0224.

The duties of the State Health Officer include the duty to "study health problems and plan for their solution as may be necessary." R.C. 1947 Supp., 23-0105(4). The Director of the Division of Public Health laboratories of the Department shall, among other things "Cause sanitary statistics to be collected and tabulated, and cause to be ascertained by research work such methods as will lead to the improvement of the sanitation of the various parts of the state;" R.C. 1943, 23-0109(4).

Cooperation with Other Public and Private Agencies. The Water Conservation Commission is authorized to investigate, plan, cooperate, and make all contracts or compacts with the United States, Canada, or any State for the purpose of preventing water pollution. The Commission may also accept and use any funds from the United States for such purpose. R.C. 1943, 61-0224.

Any State officer, department, or board which is authorized to deal with the United States or any State concerning water pollution must, before any action is taken, obtain the approval of the Commission. R.C. 1943, 61-0225.

For the purpose of obtaining financial aid from the United States, the Commission may adjust the plans and operation of any project to conform to the laws and regulations of the Federal Government. R.C. 1943, 61-0239.

The Department of Health is authorized to accept Federal funds for "public health work." R.C. 1947 Supp., 23-0111.

Municipalities are authorized "to accept aid from, cooperate and contract with, and to comply with and meet the requirements of any Federal or State agency for the establishment, construction and maintenance of public works...for the prevention of stream pollution or for sewage disposal..." R.C. 1947 Supp., 40-0501(59).

Administrative Powers. The statutes provide that all water within the State belong to the public. R.C. 1943, 61-0101. R.C. 1943, 61-0229, provides that the Water Conservation Commission "shall have full control over all unappropriated public waters of the State, whether above or under the ground, to the extent necessary to fulfill the purposes of this chapter." R.C. 1947 Supp., 61-0214, provides that the Commission "shall have full and complete power, authority, and general jurisdiction:..."

"1. To investigate, plan, regulate, undertake, construct, establish, maintain, control, and supervise all works, dams, and projects, public and private, which in its judgment may be necessary or advisable:

. . . . . .

f. To provide sufficient water flow for the abatement of stream pollution;

"2. To define, declare, and establish rules and regulations:

. . . . . .

c. For the complete supervision and control of acts tending to pollute watercourses, for the protection of the health and safety of all the people of the state;

"3. To exercise full power and control of the construction, operation, and maintenance of works and the collection of rates, charges, and revenues realized therefrom;

. . . . . .

"5. To exercise all express and implied rights, power and authority, that may be necessary, and to do, perform, and carry out all of the expressed purposes of this chapter and all of the purposes reasonably implied incidentally thereto or lawfully connected therewith."

The powers granted the Commission do not limit or deprive the Department of Health of its jurisdiction to prevent water pollution. The Commission may not declare water polluted without a finding to that effect by the Department. R.C. 1943, 61-0215.

Although, as indicated above, the statutes do not expressly authorize the Commission to hold hearings or to order persons to cease polluting water, such authority would seem to be reasonably implied from the foregoing statutory provisions.

Statutes enacted prior to 1895 authorized municipalities to empty untreated sewage into streams. R.C. 1943, 40-2204. See also R.C. 1943, 20-0612 (enacted in 1909) and 61-0114 (enacted prior to 1895), which recognize this authority. Although these statutes have never been expressly repealed, it may be that the later statutes which established the Commission and granted it water pollution control powers modified them by implication.

R.C. 1947, Supp., 23-0103, provides that the Health Council shall: "Establish standards, rules, and regulations which are found necessary for the maintenance of public health, including sanitation and disease control."

R.C. 1947 Supp., 23-0104 provides: "All rules and regulations promulgated by the health council under the powers granted by any provisions of this Act (title) shall be binding upon all county and municipal health officers, ... and shall have the force and effect of law."

The State Health Officer is required to enforce all rules and regulations of the Council and to hold local boards of health responsible for the enforcement of State regulations. R.C. 1947 Supp., 23-0105.

The county superintendents of public health are required, under the supervisory control of the Department of Health, to investigate public water and ice supplies which are suspected of being infected and to cause them to be condemned when necessary. R.C. 1943, 23-0307.

The county boards of health are authorized, under the supervisory control of the Department of Health, to supervise public water supplies and sewerage systems outside the corporate limits of any city. R.C. 1943, 23-0502.

City health officers are required to enforce the rules and regulations of the State Department of Health and of the city boards of health, the health ordinances of the cities and the health laws of the State. R.C. 1943, 23-0405 and 23-0407.

Water conservation and flood control districts may be organized on the approval of the Water Conservation Commission. The Board of Commissioners of such a district is authorized to make rules and regulations to prevent the pollution of water within the district. Laws 1949, c. 348, sec. 8.

The Industrial Commission is authorized to make rules and regulations which require oil and gas wells to be drilled, cased and plugged in such a manner that pollution of fresh water supplies will be prevented. The regulations may also require that a report of the plugging be made to the State Geologist within 60 days after completion of a well. R.C. 1943, 38-0804.

Exemptions from Operation of Act

The only exemption from the water pollution control statutes is found in R.C. 1943, 20-0612, 40-2204, and 61-0114, supra, which may authorize municipalities to empty untreated sewage into streams.

Preservation of Existing Rights and Remedies

Laws 1937, c. 255, which created the Water Conservation Commission and granted it water pollution control powers provided in section 20 that nothing contained in the act should "repeal, amend, or modify any existing Acts or statutes pertaining to the appropriation or use of water except as herein otherwise provided. . ." A similar provision was contained in the re-enactment of 1939. Laws of 1939, c. 256, section 20.

As indicated above, R.C. 1943, 61-0215, provides that nothing in the act deprives the Department of Health of its jurisdiction to prevent water pollution.

Statement of Policy

R. C. 1943, 61-0201, provides that the general welfare and health of all the people require that the regulation and prevention of water pollution necessitates the exercise of the sovereign powers of the State and that such regulation and prevention are affected with a public purpose; that the Water Conservation Commission in the exercise of its powers and in the performance of its duties shall be considered to be performing a governmental function for the benefit, welfare, and prosperity of all the people of the State.

Laws of 1937, c. 255, and Laws of 1939, c. 256, stated in sections 33 and 34 respectively that the provisions of the acts were severable and that if any one was unconstitutional, void, or inoperative, the others should remain in full force and effect.

Interstate Agencies

North Dakota participates in the following interstate agencies:

(1) The Missouri Basin Public Health Council, which includes the States within the area of the Missouri Drainage Basin Office. The other States are Nebraska, Montana, South Dakota, Wyoming, Minnesota, Colorado, Kansas and Missouri.

(2) Tri-State Waters Commission. The Commission's duties and powers include the abatement of pollution of the Red River. Minnesota and South Dakota are the other participants. R.C. 1943, c. 61-17; S.D.C., 55.4901 to 55.4905; M.S.A. 114.09 to 114.11; approved by Congress April 2, 1938, 52 Stat. 150. Although the life of the Commission has never been officially terminated, it has not functioned for several years.

(3) Inter-State Sanitary Committee. This is an informal agreement between the North Dakota, South Dakota, and Minnesota Health Departments. The Committee has materially contributed to pollution abatement of the Red River.

REVIEW OF STATE LAWS PERTAINING TO WATER POLLUTION CONTROL

SOUTH DAKOTA

Committee on Water Pollution

The South Dakota Code provides for a committee on water pollution[1] consisting of the Superintendent of the State Department of Health, the State Engineer, and the Director of Game and Fish.

The members of the committee, who shall serve without salary, shall meet at the call of the chairman to conduct hearings and other such business as may come before them. Except as otherwise specifically provided, all technical work relating to water pollution shall be done under the direction of the Director of the Division of Sanitary Engineering of the State Department of Health.

It shall be the duty of the committee to classify the public waters of the State into Class A waters and Class B waters. Class A waters are those waters in which pollution or corruption entering such waters can be so controlled that the waters receiving such pollution and corruption shall not be unwholesome or unfit for domestic use, or unsafe as a source of public water supply, or deleterious to plant or fish life, or shall not cause a public nuisance. Class B waters are those waters which are more important to the welfare of the people of the State as carriers of wastes, provided such wastes are not detrimental to the public health. No new discharge which causes any new pollution or corruption in the form of sewage, industrial, or other wastes, liquid or solid, without first having been given a permit by the water pollution committee in Class A waters shall be allowed. The committee may investigate alleged pollution or corruption of any Class A waters rendering such waters unwholesome or unfit for domestic use, or unsafe as a source of public water supply, or deleterious to plant or fish life, or which causes a public nuisance. Such investigations shall be made upon the written petition of the governing body of any municipality, or any city or county board of health, or 100 electors of the State. The Director of Sanitary Engineering at the direction of the committee shall make investigations including chemical and bacteriological analysis and submit reports to the committee covering such investigations. The committee may order the cessation of pollution after hearing if, in its judgment, the public welfare warrants it, and may make an interim order directing an offender within a specified time to refrain from doing the thing found to be the cause of such pollution. The committee shall keep a complete record of its proceedings which shall be enforced by the circuit court of the county where the pollution occurs. An appeal may be taken from any order or decision of the committee to the circuit court of the county where pollution occurs.

1/Provisions relating to the committe on water pollution are found in section 61.0106 to 61.0116, South Dakota Code of 1939.

State Department of Health

The State Department of Health is authorized to adopt and enforce orders, directions, or regulations as may be designated to protect the public health in (1) the disposal of sewage, and (2) the pollution of streams and other waters[2]. The State Department of Health by regulation requires approval by it of the plans of any disposal system before such construction may take place.

* * * * * *

While it appears that the committee on water pollution has comprehensive authority for enforcing the State's pollution abatement laws, authority in this field is also provided for and exercised by the State Department of Health. Any revision of the South Dakota statutes should take into account the possibility of eliminating this overlapping.

The powers of investigation and granting of permits by the committee on water pollution are specifically directed in a large measure toward "Class A" waters. Such powers should be applicable to all the waters of the State. The committee does not appear to have the statutory right to issue summary orders in the case of emergencies. A find and/or imprisonment is not provided for by statute for the violation of any of the orders of the Committee. The committee is not given statutory direction to develop comprehensive programs to prevent, abate, and control water pollution and to look toward interstate, Federal, and local cooperation wherever possible to achieve these ends. The present statutes do not seem to consider all legitimate uses of waters such as recreational and industrial uses.

2/ Section 27.0104, South Dakota Code of 1939.

REVIEW OF WYOMING* WATER POLLUTION LAWS

I. General Statement

The Department of Public Health has "general oversight and care" of all waters used as sources of supply for domestic purposes and of all waters "with respect to their condition and use as affecting the public health"** (Sec. 63-201). The State Board of Health, within the Department of Public Health, has been designated by the Surgeon General as the water pollution control agency for Wyoming.

General statutes relating to water pollution and control are contained in Articles 1 and 2, Chapter 63, of the Wyoming Compiled Statutes, as amended. Aside from these provisions the criminal statutes make it unlawful for the owner of any sawmill, reduction works, smelter, or other manufacturing or industrial works, or any other person, to deposit in any waters wherein are living fish any sawdust, chemicals, milltailings, or any other refuse or deleterious substance that might tend to destroy the fish or pollute or render the waters unfit for domestic, irrigation, stock, or any other purpose (Sec. 47-507). Section 9-220 makes it unlawful to poison any spring, well, or reservoir of water with intent to injure or kill a human being.

II. Administrative Organization

The Department of Public Health consists of two divisions: The State Board of Health and the Division of Administration (Sec. 63-144). Specific and direct authority over water pollution control rests in the Division of Administration (Sec. 63-149). The Board of Health acts in an advisory capacity to the State Director, who is the administrative and executive head of the Division of Administration (Sec. 63-147(1)). The Board also has authority to determine general policies to be followed by the Division of Administration in administering public health laws (Sec. 63-147(2)).

The Department of Public Health's jurisdiction in the area of water pollution control is Statewide.

Water pollution control activities of the Department of Public Health are centered in a Division of Public Health Engineering and Sanitation apparently established by administrative action. Employees are appointed subject to merit system provisions (Sec. 63-146). The power to provide for delegations of authority to subordinate officials is implied in Section 63-149.

A council appointed by the Governor, consisting of the Director of the State Department of Public Health, State Game and Fish Commissioner, State Engineer, State Commissioner of Agriculture, and five other members, including a representative of industry and a

*Statutory references are to Wyoming Compiled Statutes, 1945, as amended, Cum. Supp. 1949.

**Senate Bill No. 30, enacted by Wyoming Legislature February 9, 1951, provides that any pollution which adversely affects livestock, agricultural crops, wildlife, fish or aquatic life, is also deemed to affect public health.

representative of municipal government, is charged with the primary duty of advising the State Department of Public Health in developing a comprehensive program for the prevention, control, and abatement of new or existing pollution of the waters of the State (section 63-201).

III. Powers and duties

1. Development of comprehensive program.

The Wyoming laws do not specifically provide for the setting of standards of water purity, nor for classifying waters. Amendments in 1947 provide for the enforcement of such sanitary standards as to quality of water and as to quality of the effluent of sewage treatment plants "as are or may be established by law" (Sec. 63-149). No such standards appear to have been established "by law." However, the Department of Public Health does have broad authority in this field. It is given "general oversight and care of all inland waters and of all streams, lakes, and ponds used" as sources of water supply (Sec. 63-201); it may "cause examination of waters to be made to ascertain their purity and fitness for domestic use or their liability to impair the health of the public or of persons lawfully using them" (Sec. 63-202, also 63-112); it may "make rules and regulations to prevent pollution and to secure the sanitary protection" of waters (Sec. 63-202); it has power to abate nuisances when necessary for the protection of the public health (Sec. 63-149); it exercises sanitary control over the use of water employed in the irrigation of vegetables (Sec. 63-149).

2. Issuance of permits and review of plans and specifications.

"Cities, towns and all other corporations or persons shall submit to . . . [the Department of Public Health] for its advice and approval their proposed system of water supply or of the disposal of drainage or sewage, and no city, town or persons or company shall proceed to build or install or enlarge or extend any system of water supply, drainage or sewage disposal without first obtaining the approval of the . . . [Department of Public Health]" (Sec. 63-204).

"No sewage, drainage, refuse or polluting matter . . . shall be discharged into any such stream, spring, lake, pond . . . unless such sewage, drainage, refuse or polluting water shall have been purified, so as to render it harmless in such a manner and under such conditions and restrictions as the . . . [Department of Public Health] may direct; provided that no city or town shall be prohibited or enjoined from discharging its sewage into a river or body of water unless such sewage so pollutes the water as to be dangerous or injurious to the public health" (Sec. 63-205).

Municipal and private corporations and persons intending to construct any railroad, logging road, logging plant, electric plant, or manufacturing plant upon the watershed of any public

water supply system must first furnish the Department of Public Health with detailed plans and specifications of the sanitary precautions to be taken which must be approved by the Department (Sec. 63-206).

3. Enforcement.

Upon complaint the Department of Public Health may issue orders prohibiting the continuance of any pollution and requiring the removal of any cause of pollution (Sec. 63-207). Presumably the Department of Public Health may also issue orders on its own motion.

There are no statutory provisions for administrative hearings prior to issuance of the Department's orders.

Persons aggrieved by any order of the Department may appeal to the district court (Sec. 63-209). The statutes are silent as to whether such appeals shall be tried de novo.

Upon application of the State Department or of any person interested, the district court has jurisdiction in equity to enforce the Department's orders, rules and regulations (Sec. 63-210).

Violation of any provision of the Act or of any rule, regulation, or order of the State Department of Public Health is punishable by fine or imprisonment (Sec. 63-212).

4. Conduct of studies, investigations, and research.

The Department of Public Health has authority to make studies and investigations relating to water pollution (Secs. 63-149, 63-202, 63-211).

5. Cooperation with other public and private agencies.

There are no provisions relating specifically to action to secure to the State benefits of the Federal water pollution control act. However, Section 63-148 contains a general authorization to accept and administer Federal aid moneys allotted for public health work.

The statutes are silent with respect to agreements with agencies of other States.

6. Administrative powers.

There is general authority in the Department of Public Health to hold hearings, administer oaths, subpoena witnesses, and to take testimony in all matters relating to the exercise and performance of its powers and duties (Secs. 63-147, 63-149).

The Department has investigatory and visitorial powers (Secs. 63-149, 63-112, 63-208).

Procedures are not spelled out with relation to the making of orders, granting of permits, the issuance of rules and regulations. Requirements respecting the publication of orders, rules and regulations are contained in section 63-203.

IV. Exemptions from operation of act

There are no exemptions specified.

V. Preservation of existing rights and remedies

None.

VI. Statement of policy, severability clause

None.

VII. Interstate agencies

The State is not a member of an interstate agency.